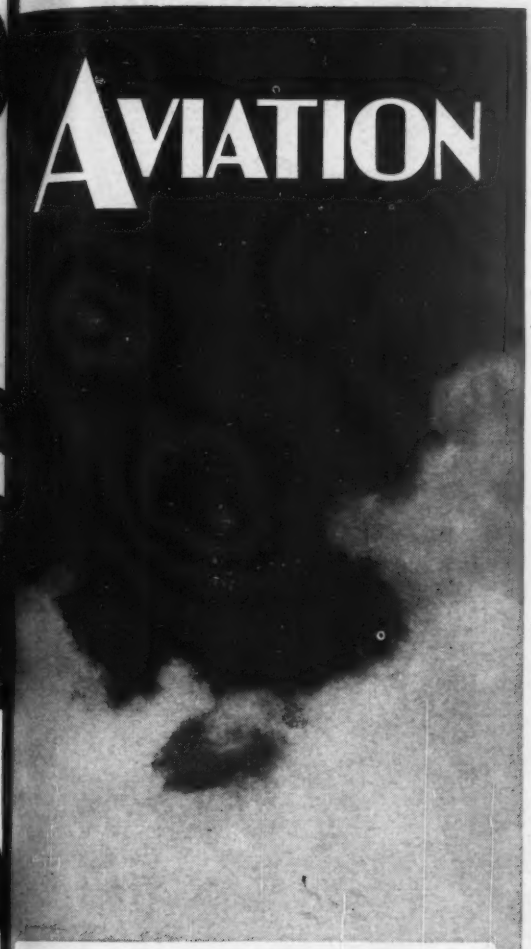

September, 1943

Volume 42 • Number 9

CONTENTS

Briefing for September 5

Down the Years in Aviation's Log 5

Editorial: Horsewhips, Inc., HAD Something 111

Aviation's War Communique No. 21 112

Banana Run ..... *John Foster, Jr.* 114

What the Postwar Buyer Wants ..... *J. H. Geisse* 116

Bombing—The American Way, II ..... *E. Eugene Miller* 118

Aviation Manufacturing

Lightning Line Brews Triple Trouble for Axis ..... *J. H. Sreenan* 121

Design Approach for Long Range Aircraft, I ..... *Robert V. Boname* 139

Curtiss Autosynchronizes Engines—Eases Pilot's Job ..... *George W. Grady, and Marvin Meyer* 144

The Case for the Integral Power Plant, I ..... *Sanford A. Moss* 150

New Guides to High Altitude Rubbers ..... *Stanley S. Kogut and Lt. Comdr. Harry J. Marx* 152

Effect of Spinner and Cowl Entrance Combinations on Engine Cooling *Julius Jonas* 159

How *Fewer* Build *More* Bomber Nose Sections 161

Super-Aluminum Alloys for Aircraft Structures, II ..... *Kenneth R. Jackman* 168

Reconversion Reserves—They're Postwar Worry No. 1 ..... *Raymond L. Hoadley* 179

Conservation in Canada's Aircraft Industry ..... *James Montagnes* 181

Wanted: A Haven for Aviation Securities ..... *H. L. Federman* 183

AVIATION's Sketch Book of Design Detail 187

Review of Patents ..... *A. Harry Crowell* 192

AVIATION's Engineering Data Book 197

New Products and Practices of the Aviation Industry 235

Air Transport

Cruise Control for Flying Efficiency, III *Dixon Speas, J. T. Farah, Sanford Hinton* 204

Maintenance

Continuous Overhaul on PAA *Clippers* ..... *David Baker* 211

AVIATION's Maintenance Notebook 217

Military

AT's Key Them for Combat (Building the AAF, II) 225

Civil Operation and Training

OWI Lists CAP Accomplishments 229

Along the Apron 229

On Patrol 229

Side Slips 201

Flying Equipment

Halifax II Features High Speed 232

The Aviation News

National Aviation 267

Washington Windsock 269

Calling Names 270

Aviation Manufacturing 272

Transport Aviation 275

Aviation Abroad 276

Financial Notes 279

Aviation People 281

Book Reviews 282

George W. Pfeil ..... *Publisher*
Leslie E. Neville ..... *Editor*
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On Leave of Absence With Government Services

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Charles F. McReynolds ..... *Captain, Air Forces*
Randolph Hawthorne ..... *Lieut., Air Forces*
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Briefing for September

Robert V. Boname, whose provocative method on Design Approach for Long Range Aircraft begins on page 139, began his career in this country with the Berliner-Joyce-General Aviation group. As head of the aerodynamics department of the French Breguet and Liore companies, he undertook the first wind tunnel tests on "motorized models" in 1934 and introduced the horizontal stabilizer with diehedral now common to so many modern aircraft. As consulting engineer for the French Air Ministry, he handled such projects as a modern towing tank for high speed and dynamic tests of boats and seaplane models, a supersonic wind tunnel, and research in engine cooling and cowling design. In 1937 he became chief engineer for Air France Transatlantique. When war interrupted his work, he affiliated with American Export Airlines.

When the revolutionary Lockheed P-38 *Lightning* first appeared, its radical design called forth a lot of criticism. Then when it proved itself—in every theater of war and for practically every purpose—the criticism turned to production; some die-hards maintained it simply couldn't be built in sufficient quantities. But again the critics have been stopped, for Lockheed has just put in operation a mechanized assembly line that's tripling *Lightning* output. Just how it's being done is told in complete detail on page 121 by J. H. Sreenan.

Kept well under wraps for a long time, the AAF's Air Transport Command has done an amazing job of "gittin' thar fustest with the mostest." Unsung—but vital—is the domestic division's so-called "Banana Run" to the Caribbean. AVIATION'S Associate Editor John Foster went over the route to find it doing a four-way job all at once. Page 114.

Every day, as American and Allied air power gains in strength, a complete understanding of the airplane's uses in war becomes more essential than ever. In the second of his down-to-brass tacks series, AVIATION'S managing editor Gene Miller gets into the doctrines of employment of aircraft types which, because a backlog of real experience is just beginning to pile up, are still taking shape. There are, however, certain fundamental factors governing the most efficient use of these different types, and on page 118 he discusses these factors as they relate to bombardment forces.

Not content with making incalculably valuable contributions to America's air power through his turbo-supercharger, Dr. Sanford Moss now turns to The Case for the Integral Power Plant, the first of his two-part series beginning on page 150. In it he takes a consensus of industry leaders and military men as the basis for enlarging upon his proposals for integral power units.

With manpower fast becoming aviation's No. 1 problem child, meeting larger schedules becomes tougher and tougher. Consolidated Vultee's San Diego plant faced not only that problem in building B-24 *Liberator* nose fuselages, but also the problem of adequate working space. How the engineers solved these puzzles, with the result that *fewer* workers actually turn out *more* units, is detailed and illustrated on page 161.

Engineers know only too well how apparently small components can have tremendous effects on an airplane's performance and how tough many of the problems involved can be. One, for example, can be found in the very nose of a plane, and in The Effect of Spinner and Cowl Entrance Combinations on Engine Cooling, Julius Jonas, power plant engineer, Beech Aircraft Corp., presents practical suggestions, with special emphasis on spinner design theory and effects. Page 159.

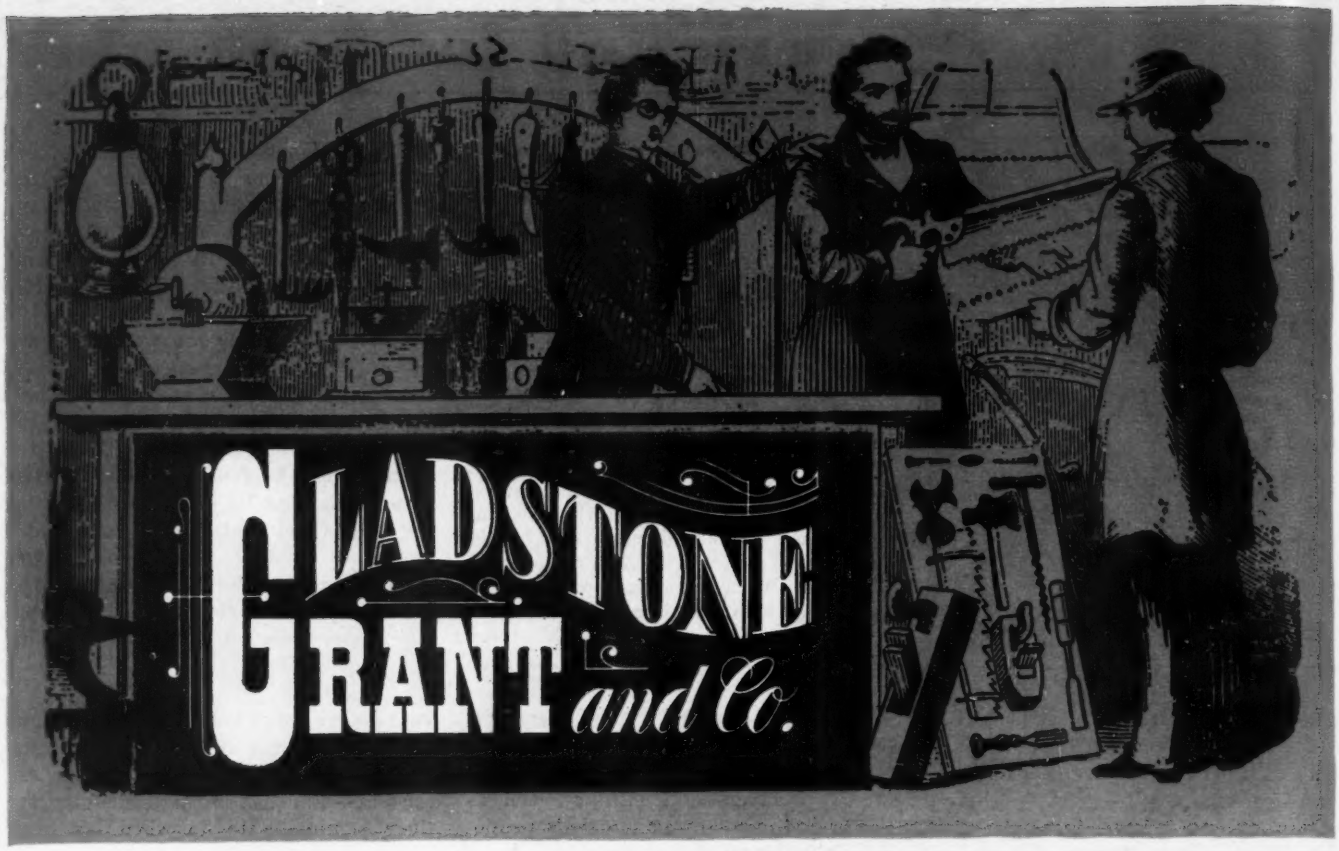
Perhaps no other industry offers such enigmas as those confronting the men charged with building airplanes to win the war—and then having something for their employees to do when it's over. These brain-twisters come under the heading of reconversion, and AVIATION'S Financial Editor R. L. Hoadley has thoroughly analyzed them. He presents the outline of a program of considerable value to the industry. It will be found on page 179.

Down the Years in AVIATION'S Log

25 Years Ago (1918)—Summary of report by Senate Sub-Committee on Military Affairs: A substantial part of $640,000,000 appropriations was practically wasted because to July 1, only 67 of 601 American-made DH-4's had reached the battle lines and not one American-built "chasse" or heavy bombing plane had reached the front. Disappointing results of program were charged to "automobile and other manufacturers who, though unacquainted with aeronautical problems, controlled the aircraft program and subordinated it to creation of the *Liberty* engine instead of carrying on its production at the same time with reproduction of approved European types".

15 Years Ago (1928)—Navy's "Sea Hawks" and Army's "Three Musketeers," latter group led part of the time by Lindbergh, stole the show at National Air Races in Los Angeles . . . WAE begins bi-weekly passenger service from Los Angeles to Salt Lake, and TAT starts air-rail service on East-West route and orders 10 P & W-powered Ford trimotors . . . Dept. of Commerce reports that on 25th anniversary of flying U. S. had 26 companies operating 32 airways over 31,240 mi. daily. Licensed pilots totaled 4,898, airplanes licensed 5,816, and 67 planes and 6 engines carried Approved Type Certificates . . . New planes announced include: Velie-powered *Cavalier* two-place monoplane. Wright-Hispano-powered 3-place *Liberty Bell* biplane, two-place cantilever wing *Kari-Keen,* and Wright Hisso-powered *New Standard* 5-place open sesqui-plane.

10 Years Ago (1933)—Aero Chamber presents code for aircraft manufacturing and transport industries operations under NRA. Manufacturers' minimum hourly wages were set at 30 and 40c. per hr. . . Chamber also reported U. S. airlines carried 229,075 passengers in first half of year, a gain of 6,000 over the 1932 period. Passenger miles gained 28 percent to 73,227,579 . . . Gen. Italo Balbo leads his Italian Savoia-Marchetti squadron home from Chicago via southern route after two-week wait for weather.

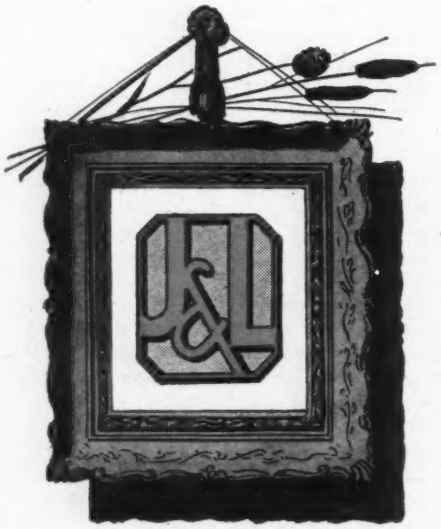


History relates that when Faraday demonstrated electricity to Gladstone, the great statesman remarked, "But what earthly good is that?" . . When Bell's invention of the telephone was reported to U. S. Grant, the general observed, "But what could it ever be good for?"

GLADSTONE and Grant once went into business together. Combining the happy qualities of diplomacy and aggression, they soon did a right brisk business in such staples as ear trumpets, harness and sundries.

They had two bright young fellows working for them named Mike Faraday and Alex Bell, and if ever a company should have gone to town, it was G. G. & Co. For it seems that Mike had been tinkering with harness for a new kind of horsepower, while Alex had invented a new kind of hearing aid . . . but they couldn't interest the management in the future of these things.

So Mike and Alex left and went into business for themselves, and they've been doing nicely ever since. While Gladstone, Grant & Co. stayed in harness and tin hearing aids, and folded like a tent in a heavy wind.



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There's a point to this little fable: Today there are many promising businesses — in the hands of capable management — that are also going to fold like tents when the post-war trade winds blow.

The success of many businesses after this war will depend upon the planning that is being done now. On any problems involving the use of precision machine tools, we urge you to call upon our engineers — as many of America's leading companies have been doing for more than a century. Call upon them now!

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Aviation—A Progress Report

The Lessons of War Become the Key to a Richer Peace

TUNISIA, PANTELLERIA, SICILY—stepping stones to momentous events! But that is not all. For they spell out across the blue waters of the Mediterranean a pattern of invasion that has progressed far since last summer's first major Commando operation against the French coast.

From Dieppe, you remember, too many of the raiders never got back. But in Tunisia, and on through Sicily, the Allied might plowed inexorably forward, winning objective after objective at a surprisingly low cost in casualties. Air supremacy over the battlefield? Yes. But we have learned, too, how to save lives and shorten the war by strategic air bombardment as a prelude to invasion.

Thus the bombardment plane—rarely seen by the doughboys on the fighting fronts—is destined to save their lives by hundreds of thousands in the decisive attacks that are to come. This fact is confirmed by the cold calculations of the responsible strategists. It will give renewed courage and confidence to every member of the armed forces and of the home fronts throughout the United Nations.

For instance: thorough strategic bombardment of an objective reduces by nearly fifty per cent the surface forces required for invasion. Anticipated losses are reduced from more than fifty per cent of the original ground force to about twenty per cent. Precision bombardment—as used on railroad objectives in Rome—reduces this percentage of loss still further when it is followed by offensive action on the ground.

This is the fifteenth of a series of editorials appearing monthly in all McGraw-Hill publications, reaching more than one and one-half million readers. They are dedicated to the purpose of telling the part that each industry is playing in the war effort and of informing the public on the magnificent war-production accomplishments of America's industries.

The inference is clear. Effective prosecution of the war will require smaller ground combat forces and much larger air forces than some of our strategists once thought.

Our most urgent need, then, is for ever-mounting fleets of aircraft. And, fortunately, this is just what we are getting. The American aircraft industry now is producing as many airplanes as all the rest of the world combined. In 1938 we made 100 planes a month. Now we make three times that many in a single working day. By the end of 1943, our production rate will be about 10,000 a month.

But at this stage of the war, types of planes are more important than mere numbers. In the early months the program was heavy, and properly so, with single-engine trainers. Then, as training planes accumulated, the emphasis shifted to heavier types. Now we are turning out multi-engined bombers at a rate that is the envy of the entire world. Some months ago the President revealed that we were manufacturing 500 long-range bombers every month. The figure was conservative even then. And soon we shall be producing planes of this one type at a rate adequate to replace the normal losses of a fleet of at least 1000 American heavy bombers operating as continuously as the weather will permit.

A glimpse of the poundage production may help us still further to evaluate the miraculous achievements of the aviation industry as a whole. It was 89,000,000 in 1941 . . . 291,000,000 in 1942 . . . 911,000,000 in 1943 . . . and 1,417,000,000 in 1944

– if we need it. There you have the magnificent record of the American aircraft manufacturing industry – a monument to the cooperation of industry, labor, government, and to all-out teamwork between the aviation industry and those other industries which have converted their facilities to the manufacture of airplanes.

What of our enemies and our Allies?

German production probably has flattened out at 2500 a month – with downward revision in immediate prospect. Japan may be able to produce as many as 1000 planes a month – until we get our new long-range super-bombers in sufficient numbers to whittle down that figure. Italy may be able to turn out her 500 a month – for a little longer. At best the maximum Axis monthly total is 4000.

Add to our monthly score of nearly 8000, a total of approximately 4000 for Britain, Canada and Russia, and the United Nations score comes to 12,000 monthly. There we have a three to one advantage for our side. And between our own rising production and the brilliant operations of our bomber commands we should soon boost the ratio well above that figure. Therein lies the certainty of continued and growing air superiority over all the far-flung battlefields.

The critics of American airplane quality have been silenced ever since the ratio of enemy combat losses to our own on bombardment missions surpassed four to one. In the Pacific where our heavily armed and armored planes are knocking off the desperately stripped racing craft of the Nipponese, enemy losses often run as high as eight to one or more. In the Mediterranean theater, where the Italians were abandoned by their Allies, the story is much the same. Only in the well-defended homeland of the Nazis do we sometimes drop below the average, but even in those rare instances the ratio is still well in our favor and the effectiveness of our bombardment is adding constantly to our margin.

* * *

Behind the production lines the battle of research and design still rages. In many a laboratory night-shift, on many a secret test field, new and terrible surprises for the enemy are in the making. Super-bombers, destined for Tokyo, have long since passed out of the design stage and the Japanese may learn about them almost any day. New discoveries, designed to sow swift and silent devastation, are farther along than our enemies believe. No longer will fog or storm or night be permitted to fight on the side of our foes.

The men of science who are toiling to broaden the horizon of our knowledge stand today on the threshold of discoveries that have been sought for centuries. New reservoirs of power may soon exert a profound influence in many fields of technology and through them on our way of life.

Once the war is won these new discoveries will be translated into better living. No longer will countless thousands spend their lives within their own communities or countries. New efficiencies in transportation will bring world travel within the reach of many who once had to stay at home. New family vehicles will navigate the skyways as easily and safely as the highways. Already more than a dozen manufacturers of airplanes, ships, automobiles, and electrical equipment are designing, building, or flying rotary-winged aircraft such as the helicopter or autogyro to meet the needs of tomorrow's families. New and safer aircraft of the fixed-wing type are ready for production as soon as materials become available.

The quality that now makes each of our war planes worth so many of those built by our enemies will be translated into the sturdy reliability demanded by peacetime operation. The devices that seek out and find our enemies behind the veil of fog or darkness will, after the war, reduce weather hazards to the point where they will be no greater in the air than on the ground.

Science and industry will continue to do their jobs and do them well. But if the world is to be made a better place for men to live in, statesmanship must not fail to do its part.

President, McGraw-Hill Publishing Company, Inc.

Horsewhips, Inc., HAD Something

THERE WAS AN OLD MAN who made whips. And better whips couldn't be bought. His father had made them. His granddad had made them. Their products were eagerly sought by coachmen for ladies in crinoline, farmers, and lion tamers. The business had thrived and the family had prospered for four generations. Each time the factory was handed down to a son, the father told him, "They will always need whips."

Then came the day when the chug of a horseless carriage up Main Street sounded the death knell for Horsewhips, Inc. The crinolined ladies traded in their fine coaches for ornate, brass-trimmed Maxwells, the farmers began to mechanize, and only the lion tamers continued to be customers. The old man passed on in unhappiness. His son saw no need to perpetuate the business. And his grandson made no attempt to revive it even when a shortage of gasoline in certain Republican states threatened a temporary return to the horse and buggy.

What has all this to do with aviation? Just this: Manufacturers of airplanes and powerplants have reached a stage of complacency that is full of danger. In the flush of their unquestionably brilliant achievements, they are taking a little too much for granted. True, we do not doubt that "they will always need aircraft"—but will they be airplanes of the same type with power plants of the same type?

MOST OF US in the airplane business are inclined, naturally enough, to think of the present period as the age of flight. But with further analysis we can readily see that this age of flight is but a part of the age of the internal combustion engine. All of our transportation progress in the air and on the ground goes back to the discovery of a more efficient and more compact power source. Technology has worked wonders with the gasoline engine. From a crude, heavy collection of metal weighing many pounds for each horsepower produced, it has become a beautiful mechanism of great power and lightness. But we may be reaching a point where the only remaining way to meet demands for more power will be to increase the number of cylinders, thereby complicating the mechanism. Some day, someone, somewhere, is going to develop a brand new approach to the problem and come up with a new power pack that will be more efficient and compact—as much more as the gasoline engine was over its predecessors. And so it behooves all of us who so well know the reasons why freak engines will not work, to open up our minds and go back with a fresh outlook toward diesels, turbines, jets, remote power sources, and even the fantastic power devices.

SIMILARLY we should remember that our cave man forefathers did not get very far until they substituted wheels for skids and learned that rotation was more efficient than translation. Coming back to our own century, perhaps it is more logical that a wing derive its lift by rotation instead of translation. Anyway there are a score of companies that are now either flying, designing, or about to try to design rotary wing aircraft. And it is to be noted that some of these companies are very substantial organizations outside of the aviation industry.

It is no safer to say "they will always need gas engines and fixed wing aircraft" than it was for the four generations of whip makers to say "they will always need whips." We must take down from the shelves and dust off all of the seemingly impractical, idiotic ideas of yesterday and re-examine them with wide open minds in the light of the most recent developments in metallurgy and other sciences. Only by doing this—doing it honestly and fairly—can we avoid the sad plight of the little old man who made whips.

Leslie E. Neville

EDITOR

Press Association

Outstanding precision bombing of the month was long-range raid by 175 Consolidated B-24 *Liberators*, which made 2,400 mi. round-trip to Ploesti, Rumania, where they "worked over" largest single source of Luftwaffe fuel. Planes went over targets so low that flames sprang higher than many planes which hurtled across to deliver finishing touches.

America at War

Allied air power efficiency increasing swiftly . . . Sicilian invasion gives gliders shot-in-the-arm . . . precision bombing scores again in Ploesti raid . . . Pacific air power growing faster, but vital Chinese bases still in realm of future . . . our production gains have officials worried . . . airmail situation continues redolent.

ALLIED AIR ATTACK is cutting down German aircraft output while Nazi aviation is unable to touch the production facilities of the United States and only to scratch those of the British. The only thing that can stop the enemy's eventual decline to zero air power is cessation of hostilities.

Results of Allied attack on Hitler's airplane production, apparent these last months, is now obvious. Luftwaffe's fighter resistance is observed by our bomber pilots to be growing weaker. Goering is shifting from bomber and attack planes to fighters—and defensive fighters at that. German factories are backing away from the attack to the south and west. Our increasing range is following them west, and positions in Sicily and, perhaps Italy can help meet them going south.

Apparent German determination to defend Italy to the bitter end—whether the Italians want it defended or not—indicates the Nazi leaders recognize this pressure upon them only too well.

Then, too, the great part played by air power, especially American, in reducing Sicily in less-than-scheduled time must certainly put Hitler back on his rug-chewing diet. For there was employment of air power as efficient as has been seen in this war. It included the largest use to date of gliders, and glider men here were more than elated. True, mistakes were made, but training has already been changed to prevent their recurrence. Perhaps the impetus didn't come from Sicily, but the fact remains that the glider program seems to be "in" again, with production expansion the keynote.

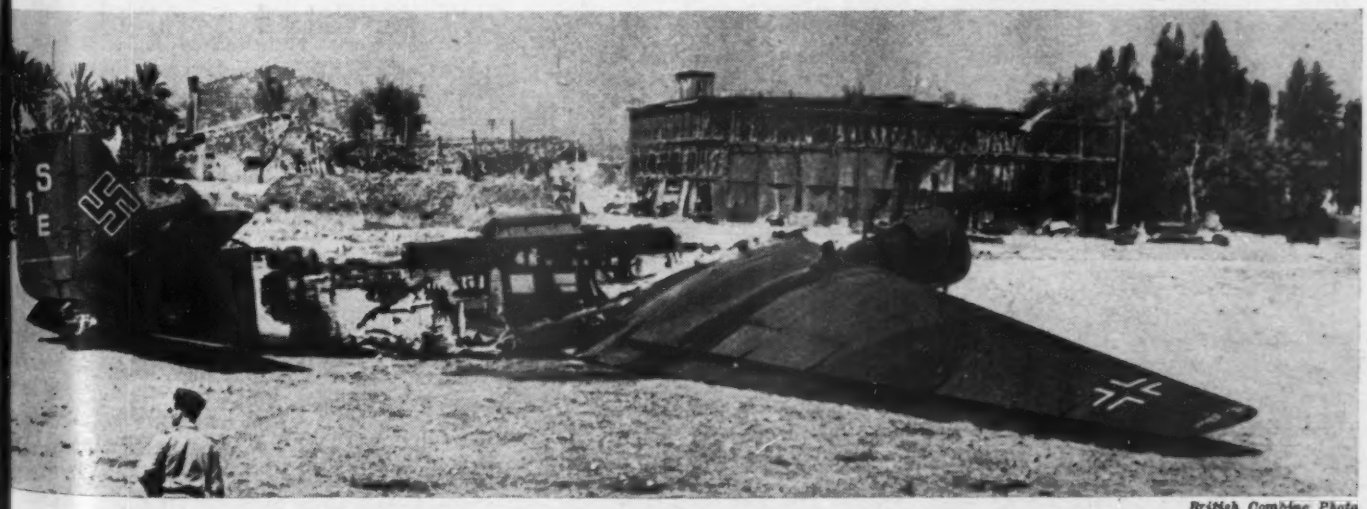
News dispatches report goodly portions of the German populace moving fearfully out of devastated or "marked" cities to get out of the way. Thus far this movement has, of course, been an orderly one, avoiding repetition of the congestion on roads which tied Poland and France in hard knots.

Neutral sources in Europe are beginning to wonder how long the German people can take it. Thousands are being killed, wounded, and made homeless; already they have been brought to relief centers by train loads. What happened to England is peanuts by comparison.

Hamburg was pounded into a heap of ashes and stone and warped steel, and today it is virtually a deserted city except for guards and fire squads. One third of a 1,000,000 people living in its harbor area were blown out of their homes by saturated area attack. There is nothing pollyanna-ish about Allied air war on Germany, any more than there was about Nazi bombardment of England. The population—the workers—of the enemy country are just as much a part of their forces against us as are their physical plants, their pilots, ships, and planes.

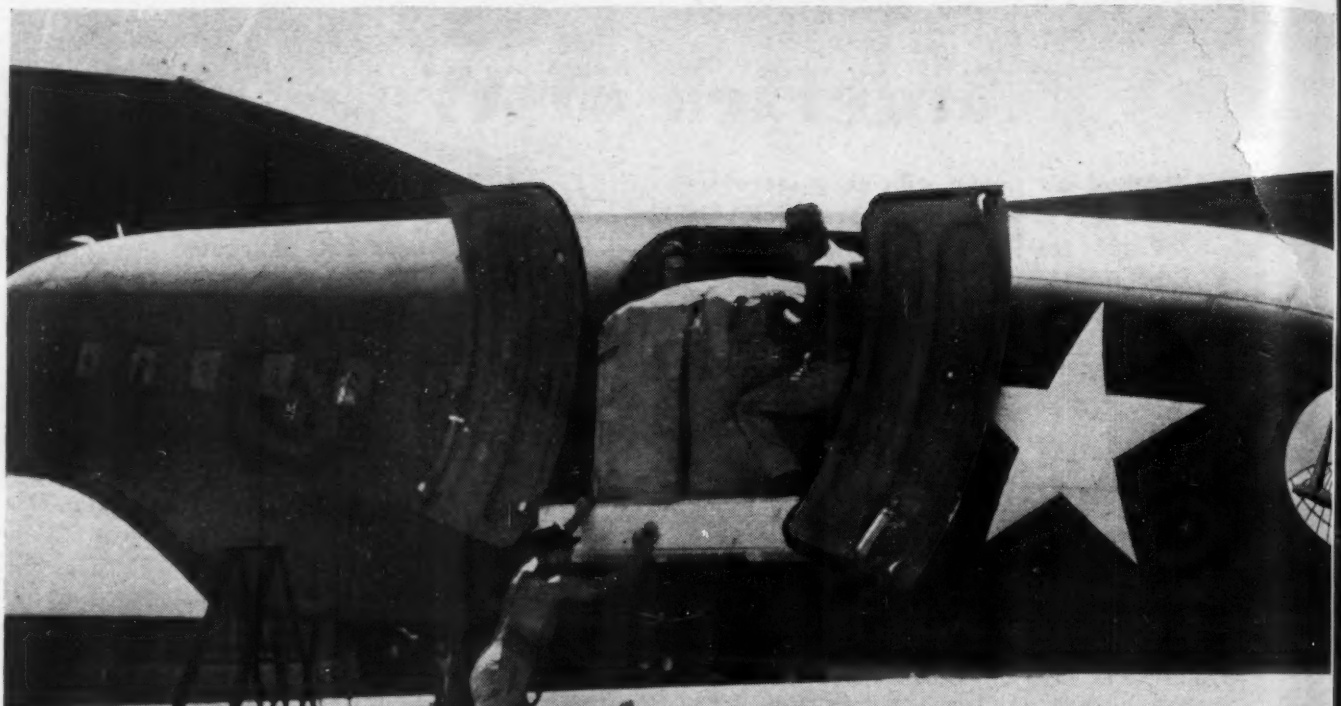
It has all tended to revive some of the arguments of precision vs. area bombing. Hamburg in its en-

(*Turn to page* 326)



British Combine Photo

Growing efficiency of our air power was demonstrated with a vengance in Sicily, where Nazis learned—from the receiving end—about destruction of air, land, and sea transport, and loss of air bases from which to operate. Thoroughness of Allies' work is exemplified in photo above, showing destroyed Junkers Ju-52 transport and gutted airport facilities.



Army Air Force' Air Transport Command schedules on its "Banana Run" aren't delayed by cargo loading, which has been developed into a fine art. More than two tons of cargo are consistently loaded and lashed by a five-man crew in half an hour. Off-loading at intermediate Central American points takes less time than re-fueling.

BANANA RUN

By JOHN FOSTER, JR.
Associate Editor, "Aviation"

AAF'S Air Transport Command not only flies " hot freight" to Caribbean Defense Zone, but also does outstanding diplomatic and training jobs . . . —A first-hand report by an AVIATION editor who flew the route to get the story.

THEY CALL IT the Banana Run—but it doesn't fly bananas, because too much hot freight and soldier-bound mail and too many high priority passengers have to be moved in a hurry.

Although it doesn't go into an active war theater, the Brownsville-Panama Canal Zone route of the Domestic Transportation Division of the U. S. Army Air Forces Air Transport Command is not only doing its share in winning the war by helping keep that theater a quiet one, but is doing a four-fold constructive job whose value will last far beyond the end of the war.

For, first, it is getting men and materials where they're needed when they're needed; second, it is giving young Army pilots transport training they couldn't possibly buy; third, it is doing a diplomatic job that committees and goodwill missions might never accomplish; and last, but far from least important, it is compiling a vast store of operating and maintenance know-how in record time.

Just how this four-fold job is being done can best be shown by a typical round trip, one that began, not so much with the actual takeoff, but with the preparations which make the flights the regular scheduled operations that have proven to be the most efficient type of operation.

At the line's northern terminus there are no really quiet hours; some are just busier than others. To start with, there is completion of the north-bound schedules—just how many schedules cannot be revealed. It is at this stage that maintenance crews, composed of civilian employees of the contracting commercial airline, swarm over the Douglas C-49's that once were luxury liners and the C-47's, their cargo-lugging counterparts.

These crews perform first, second and third echelon overhaul in remarkably short time, for Banana Run planes are

in the air more than twelve hours a day, week after week. On the day the author started over the line, for example, one of the "work-horses of the Air Force" completed its north-bound run, got a 100 hr. check—which included going up on the jacks for main landing gear service and installation of a new tail wheel—and was on its way south again, fully loaded, within 9½ hr. In addition to keeping the planes in the air long hours daily, the maintenance chiefs are constantly training new crews of Army enlisted men in Douglas transport maintenance.

Cargo handling, the trip revealed, has already developed into a fine art. Typical was the job done that night by a crew of five former stevedores, civilian Air Service Command employees, who loaded 4,200 lb. for three separate destinations in 31 min. They followed the loading chart, too, for an Air Transport Command officer was on duty—as he is for every load—to supervise and check. The Air Service Command, which handles all the ATC cargo until it is tied down in the plane, has done an outstanding job of breaking shipments down to size for loading through narrow doors and re-packing in light, yet sturdy containers which mean more cargo and less packing material. Off-loading, of course, seldom if ever requires more time than re-fueling, for more than 4,000 lb. have been consistently cleared from the plane in from 12 to 15 min.

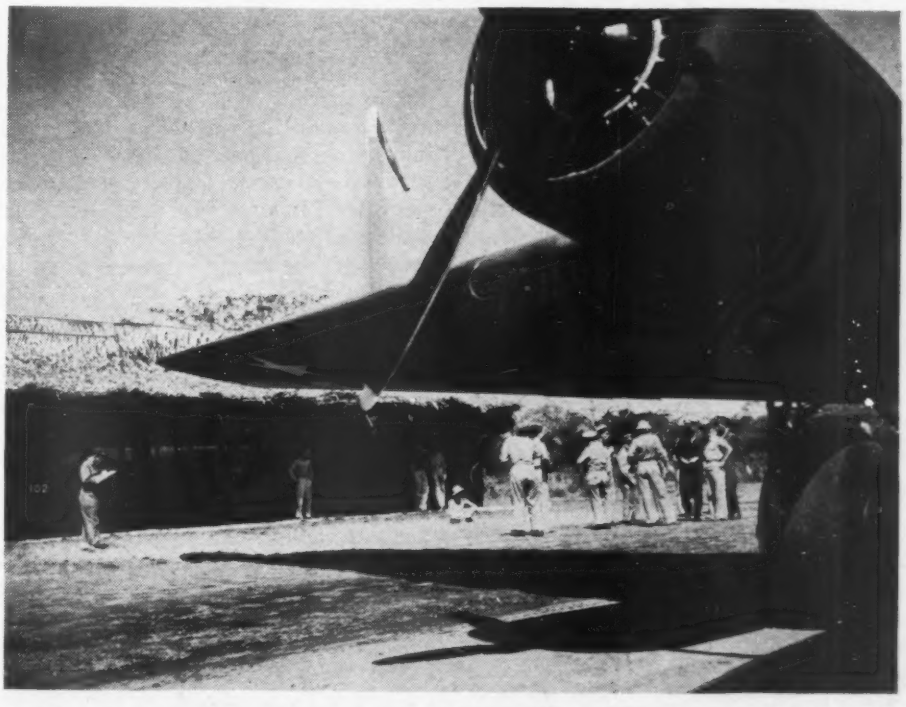
During the maintenance and loading, some done simultaneously, ATC operations officers had been preparing flight plans, briefing student co-pilots and observers (one each making every trip), and preparing clearances. At least one part of the work of international clearances had been greatly simplified, for what had been a long, tedious communications-tying job when the line first started has become routine largely through the efforts of Banana Run's control officer, Maj. Floyd H. Davidson, a former airline pilot. Working in closest cooperation with high ranking officers of the Mexican Air Force, he had arranged for a representative, empowered to prepare necessary papers for clearances over, in, or out of Mexico, to be established in the line's northern terminus offices. Not only has this procedure proved much more efficient for the line's operations, but it has helped materially in bettering understanding between officials of the two republics.

Scheduled departure times were at a decent hour by the Greenwich Mean Time clock under which the line operates, but it was a long time before dawn when, with the other planes taking to the air, the ATC contract pilot asked, "What are we waiting for?" His question meant getting away a few minutes early, for his crew—co-pilot and radio operator—plus a student co-pilot and observer were ready, and the cargo had long since been stowed and secured. The omnipresent customs and immigration gamut had been run by the two passengers, an Air Corps colonel enroute to take command of a new post and this correspondent.

ATC's Banana Run is doing an outstanding job training young Army pilots in international transport work. Much of the line's terrain and weather, such as this, are "slightly rugged"—very much like the territory transition pilots may meet later on in war theaters, where they will often fly half or more of trips on instrument.

"Old 82" was well within load limits that trip, but some of the cargo was bulky. Principal weight item was more than 1,000 lb. of mail, something whose value cannot be over-estimated, for the line has cut former delivery time of from two to four weeks down to a

(*Turn to page* 314)



Central American jungle outpost where ATC Banana Run cargo planes refuel is mixture of both military and civilian personnel. American Air Forces personnel service planes; country in which it is located has military representative, and other Central American nations have civilian representatives to handle flight clearances. Close harmony with which they work is tribute to diplomatic and international relations job being done by ATC in addition to getting men and materials where they're needed in a hurry.

What the Postwar Buyer Wants

By J. H. GEISSE,
Civil Aeronautics Administration

Surveys on why private pilots gave up flying and what former owners thought of their planes indicate changes designers and manufacturers must plan today in order to create and sustain the potential market.

THERE IS LITTLE QUESTION that after the war there could be a vast expansion in private flying equalling some of the most optimistic forecasts. But it is questionable that such a boom will last if the industry does nothing more than supply the accumulated demand for personal planes.

This latter fact is indicated by Civil Aeronautics studies which show that the ratio of new pilots certified to student certificates issued remained substantially constant at 15 percent from 1933 to 1938 (see Fig. 1).

In 1940 the author made a study of private plane ownership from the records issued annually by the Aeronautical Chamber of Commerce (Fig. 2). This curve has been extrapolated to 30 yr., the longest period of ownership assumed for one individual. The average term of ownership is 3½ yr., and the consistency of the attrition rate is notable. Assuming plane life to be 7 yr., this means an average present consumption of one-half a plane per owner as against a probable rate of more than four automobiles.

And both this study and those made by the CAA indicate that only about 15 percent of the people who tried flying continued to keep at it.

Peace will bring us many trained pilots as customers, but we must make improvements and refinements in planes to keep 'em flying. If we are prepared, the boom will be on. If we are not ready, the people who are bound to try private flying after the war will soon give it up. So if major changes are necessary in our product we must plan them now. Unlike automobiles and refrigerators, which might be put on the market for a short time in prewar models without serious consequences, presentation of private flying as it was before the war might well destroy a large part of the market prepared by the war and could destroy any opportunity it might have of aiding in the postwar readjustment.

Ideas will differ materially as to what changes will make our product more universally accepted. However, let's not make the mistake of letting the flying enthusiast dictate the improvements. He is an infinitesimally small fraction of the possible market and a repeat customer already. We should be more concerned about the man we have never been able to sell and the man who bought our product and discarded it.

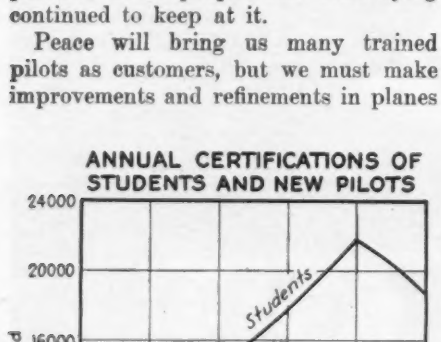


Fig. 1

Flyers' Objections

Two surveys of dissatisfied customers, made by the CAA in 1940, give us some inkling as to what changes might answer objections to private flying. In one, questionnaires were sent to former holders of student permits who had discontinued training before securing a pilot's certificate. A summary of answers received from 436 of these former students is shown in Table 1. In the other, questionnaires were sent to former owners to determine why they had sold their planes (Table 2). Here, of 355 replies received, 184 were from owners who had received no revenue from the operation of their planes. Their thoughts as to which plane characteristics had been stressed too much or too little by the designers are indicated in Table 3. Of these 184, all but 15 held some form of pilot's certificate during ownership, but at the time of answering the questionnaire 118 held no pilot certificate of any kind.

Cost came first in both surveys. However, it should be remembered that cost is always weighed against value received. It is probable that many of those who started instruction or purchased airplanes (other than those who indicated financial reverses) could have cut other living expenses sufficiently to carry on their flying if they believed it would result in a net gain.

The first significant item after cost is the inaccessibility of airports. This is a definite function of size. The larger the airport, the farther one must go from population centers to find available land. Cost increases with size, hence fewer fields can be supported in any community. Simple, one-way landing strips of about seven acres, in contrast to the present average of 175 acres for non-scheduled airports, might be an answer. One-way landing strips require airplanes constructed so they can be landed easily in crosswinds by relatively unskilled pilots. The stable undercarriage or tricycle landing gear would make this possible. Initial cost of strips would be about 1/20 of that of our present fields.

If placed alongside highways, service stations might take care of both the highway and the landing strip better and cheaper than at airports. There are already indications that some oil companies might be interested in building such service stations. Although poor service does not appear directly in either of the surveys as a reason for giving up flying, it is known to be one of the most common complaints of the private pilot.

Ranking next to the inaccessibility of airports is the lack of utility of the private plane. A serious drawback is the possibility of being forced down by weather. Even the threat of it frequently precludes any attempt to make a trip by airplane. Roadable airplanes, or flying automobiles, would greatly reduce the number of trips which would have to be given up because of weather, since the time lost would be measured by the difference in speed in the air

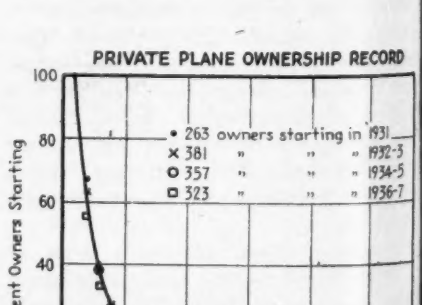


Fig. 2

Winner of the Dept. of Commerce safety competition in 1934, the Hammond airplane, says the author, indicated a wide public demand for safety and visibility.

and on the ground and not by the duration of the bad weather. Also it frequently happens that the weather is non-flyable for only a short distance and flight can be resumed if there is some way of passing through the affected area.

An alternate and quite different approach to improving the ratio of utility to cost for the private pilot who is not an owner is the "fly-yourself" service. It offers a partial solution to weather interruptions, since the renter would be able to turn in his plane and continue his trip or return to his starting point by other means of transportation if the weather became unflyable. Idle time could be reduced to a minimum since the individual plane would not have to be kept out of service until the renter desired to make a return trip. Costs could be reduced correspondingly by quantity purchase and maintenance. A flexible rate structure could equalize the flow of traffic, keep ferrying costs down, and encourage shifts in concentration of equipment with changing local demand.

One attempt to solve the weather problem was made in 1935 when the Bureau of Air Commerce fostered the development of a roadable autogyro by the Pitcairn Autogyro Co. The rotor blades could be folded back over the tail surface which were kept within the limitations of highway regulations. The propeller could be disconnected and the engine power delivered to the rear wheel. By flying under the ceiling and running on highways, this vehicle was able to make a trip from Washington to Miami when weather had forced down airplanes attempting the same route at the same time.

A short time later Waldo Watermann developed his "Arrowbile," a tailless airplane with removable wings. Like the autogyro, its power could be delivered either to the propeller or to the rear wheel. It was also equipped with a landing gear suitable for flight strips. The body section alone was operated for a time in Los Angeles as an automobile and, with wings attached, it was flown to the National Air Races at Cleveland with the handicap of the added weight of an automobile engine, used to reduce cost.

None of these changes in design can be made without some reduction in top airspeed. However, one of the most significant results from the survey of past owners (Table 3) was the revelation that for the most part they would have sacrificed speed for lower landing speeds and greater comfort. They favored this when top speeds were probably well under the 120 mph. cruising rate often specified as being essential to permit the postwar airplane to compete with the automobile under unfavorable wind conditions.

It is also notable that these owners would have accepted this reduction in cruising speed for characteristics with little or no compensatory effects in point-to-point time. But general acceptance of some of these changes—roadable planes, fly yourself services, and highway landing strips—might not only make up for speed and time lost in design changes but also go a long way toward answering some of the complaints of people who have bought planes and found them not worth their cost.

TABLE 1

WHY STUDENTS DID NOT BECOME PILOTS

Reasons for obtaining student certificate:	Percent
For pleasure	37.2
To fly commercially	28.4
For pleasure transportation	13.3
For business transportation	7.2
As an accomplishment	7.4
To determine desire to fly	5.5
For privilege of student certificate	1.0
Reasons for not continuing flying:	
Expense greater than anticipated	29.5
Change in financial status	27.1
Too much time lost going to airport and waiting for plane	9.0
Unsatisfactory training accommodations	8.3
Change in family status	3.6
Too much flying time required to keep in practice	4.3
Family objections	5.0
Flying not as useful as expected	1.8
Pleasure less than anticipated	.5
Hazard greater than anticipated	.2
Flying more difficult than anticipated	.6
Other reasons	10.1
	100

TABLE 2

WHY OWNERS GAVE UP FLYING

	Percent
Expense greater than anticipated	30.3
Change in financial status	19.7
Too much time to and from airports	8.9
Not as useful as expected	6.8
Desired flying time procured	5.1
Change in family status	5.0
Too much regulation	4.2
Pleasure less than anticipated	3.0
Family objections	2.5
Too much time to keep in practice	2.4
Miscellaneous	12.1
	100.0

TABLE 3

WHAT OWNERS THOUGHT OF PRIVATE PLANES

	Too Little Consideration	Too Much Consideration
High speed	8.4	22.0
Low speed	5.7	2.2
Comfort	9.0	2.3
Safety and ease of control	5.0	5.5
Miscellaneous	26.0	12.9
	54.1	45.9

Selling the Unsold

However, it would be a mistake to assume that such changes will satisfy all potential postwar customers. For any increase in the size of the planemaker's market will result chiefly from attracting people who have not bought before. And their wants may differ from those of past customers.

The man we have never been able to sell has cash in his pocket but stays away from the airport. And the boy who hangs around the airport has no cash. There is a wide divergence of opinion as to what the former, our future customer, wants in a plane. The author is convinced that in addition to the changes already suggested, we must attract him with one that is safer, more

(*Turn to page* 312)

Bombing . . . The American Way

Part II

By E. EUGENE MILLER
Managing Editor, "Aviation"

Our doctrines of employment of bombardment forces are taking shape more clearly as experience is gained. Discussed in this article are the fundamental determining factors in their efficient use.

THE AIR ARM is a relatively new military branch, and as a consequence it is almost bound to be frequently misused by all belligerent powers. The problem of determining correct employment becomes aggravated by the fact that since the present war began, air force requirements have expanded considerably out of proportion to prewar concepts and preparation. Therefore, there are inevitably too few commanding field officers in any of the armies who really understand correct employment of air power in all of its phases.

The mere pinning of wings on high ranking officers who have just completed advanced flight training does not make them true air officers, as proved in the case of German generals and admirals who, after being given as much as two years' training with the Luftwaffe, still were found considerably lacking in air force comprehension. Likewise, a thoroughly trained and experienced bomber commander is not really qualified to direct the employment of fighter or ground support equipment any more than an artillery specialist can be trusted with the final word on infantry employment.

With the sudden blossoming of air force requirements, it was necessary, in many instances to place relatively unqualified officers in charge of combat forces. This was not a unique condition in Germany. It was common to all belligerents. To a large extent this condition has been corrected, and as a result we are beginning to see a more well-defined doctrine of air power employment.

The bombing function is unique in that it is principally a strategic force rather than tactical, as are fighter and ground support units. Therefore, its operations are continuous whereas the other air force divisions are employed as tactical requirements dictate. Yet, as the doctrines take shape, we can see a subdivision within the bombardment branch which may be further differentiated with respect to tactics and strategy and which fairly parallel the classification of bomber aircraft types, i.e.—

Medium bombers—Tactical employment
Heavy bombers—Strategic employment

It is dangerous to generalize in this manner, however, particularly with respect to equipment, because there is a legitimate and continuous overlapping of employment depending on circumstances. For example, a fighter group may effectively perform the tactical functions of defense and ground support, or it may carry out the strategic function of destroying enemy sources of supply and lines of communication.

Definitions of Tactics and Strategy

• Strategy and tactics are interrelated to the extent that the degree of tactical situations, both with respect to number of occurrences and severity of combat requirements, depend on the results of strategic operations.

Successful and persistent strategic operations reduce the number of times a tactical situation can occur during the course of a campaign and also definitely affect the ability of the enemy to maintain a force of resistance in the course of a tactical operation.

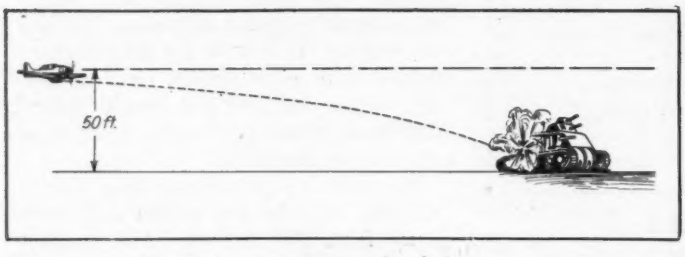
A tactical situation arises as a manifestation of the full force and purpose of a military effort. It may be brought about as a result of strategy, but (just as important) it may be favorably prevented or favorably reduced in degree of intensity by strategic operation.

While strategic operations include tactical operations, they are more fundamental and actually determine the character of the tactical operation.

Both strategy and tactics are involved in any contest. Strategy involves all efforts designed to put an opponent in an unfavorable position for combat. Tactics are the measures designed to defeat the opponent, and they are applied upon contact whether the opponent is in a favorable position or not.

To cite an example, an enemy soldier is placed in an unfavorable position if, as a result of strategic operation, he is deprived of his ammunition or food supply. On the other hand—whether or not he is well armed or well fed—a tactical situation occurs when time comes to remove him as a factor of resistance. This ultimate objective of all military operations is attained in a relatively simple manner if a successful strategic operation deprives him of the means of resistance.

This lengthy dwelling on definition is important if the full significance of bombardment is to be realized, for bombardment is the principal strategic force of our Army. Specifically, it is the strategic force in the term "air force."



Minimum Altitude Bombing Technique

Normal technique against moving surface targets is shown at left, where plane approaches at high speed and at low level literally to throw bomb horizontally at target. If bomb falls short, it will "skip" into target with equal effectiveness of a direct hit. If it falls too short, however, it may ricochet over target. This is probably the most accurate bombing technique employed.

A heavily armored cruiser may be sunk or damaged by causing the bomb to fall short and skip up to the sides of the ship without penetrating. Bomb will then sink and explode underside against lightly sheathed bottom. If normal minimum altitude bombing technique were employed, chances are bomb case would rupture against heavily armored sides. Fusing plays an important part in this specific operation, since bomb should not explode until it has sunk beneath armor.

Likewise, a heavy bomber may be employed tactically at short range against enemy shipping, ammunition dumps, or even troop emplacements. However, it is important that these missions be so performed as to be within the limits of genuine necessity—for to employ specialized equipment indiscriminately is outright and inexcusable mis-use of air power.

In total war, the strategic functions outrank those of tactical importance simply because strategy dictates the nature of a tactical situation. So long as a war is conducted there can never be enough strategic weapons—but there may be a limited requirement for tactical weapons. For example, no belligerent nation has really enough submarines with full complement—each could use many times the existing number. Yet it is quite conceivable that there may be sufficient tanks or guns and that production of them may safely be tapered off, or even stopped, barring replacement considerations.

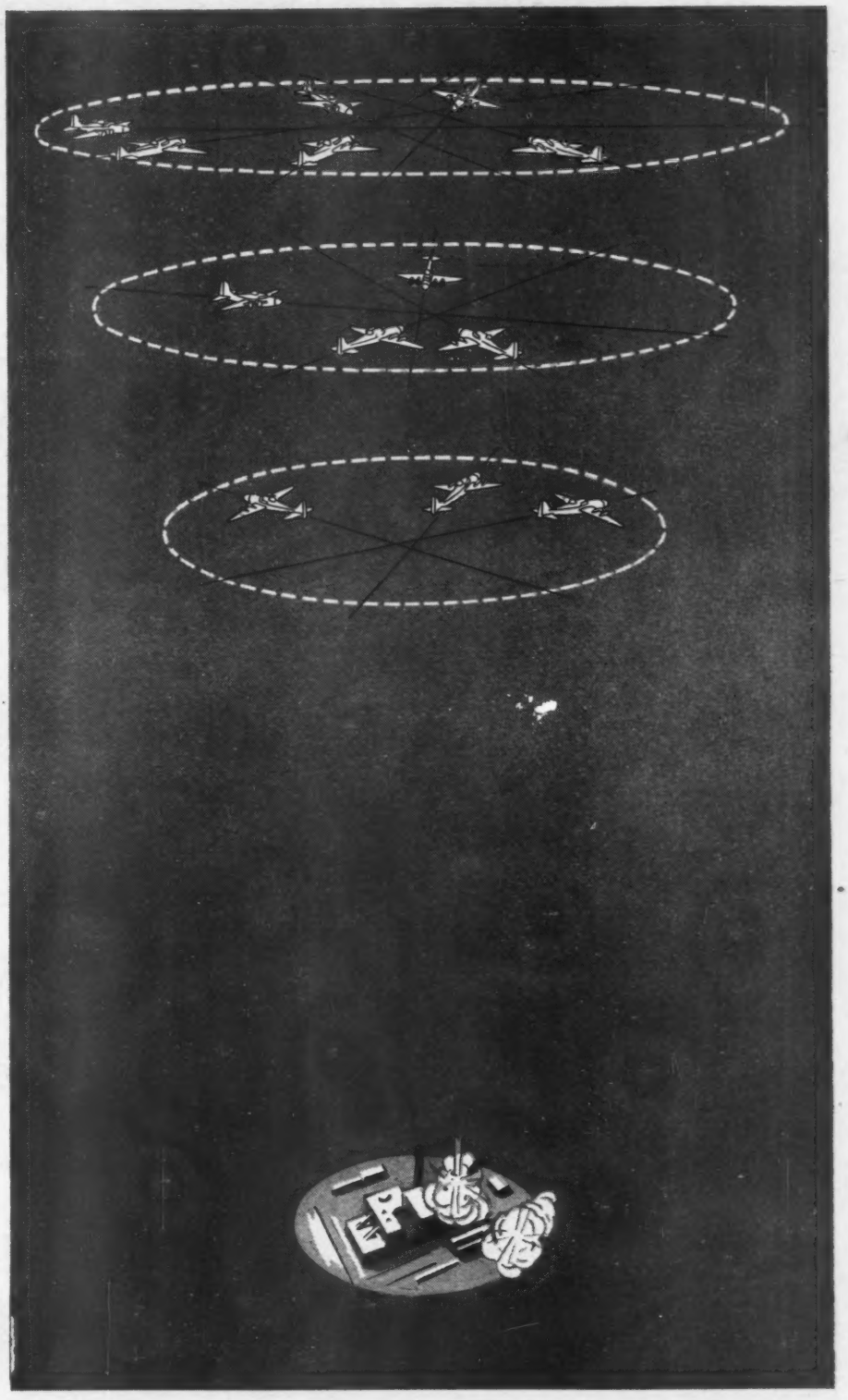
So it is with the strategic heavy bomber. This weapon is the only one which can penetrate, at long range, enemy territory, striking at his source of power to resist. So long as the war goes on, there will never be enough "heavies," and they must be carefully husbanded and employed as efficiently as possible. Their use on any mission that may be carried out by other aircraft types must be dictated by true necessity and only where the combination of conditions is such that other available types cannot effectively do the job.

The long range heavy bomber is used most effectively for operations well behind the enemy lines against production installations. Properly conducted missions of this nature will reduce the

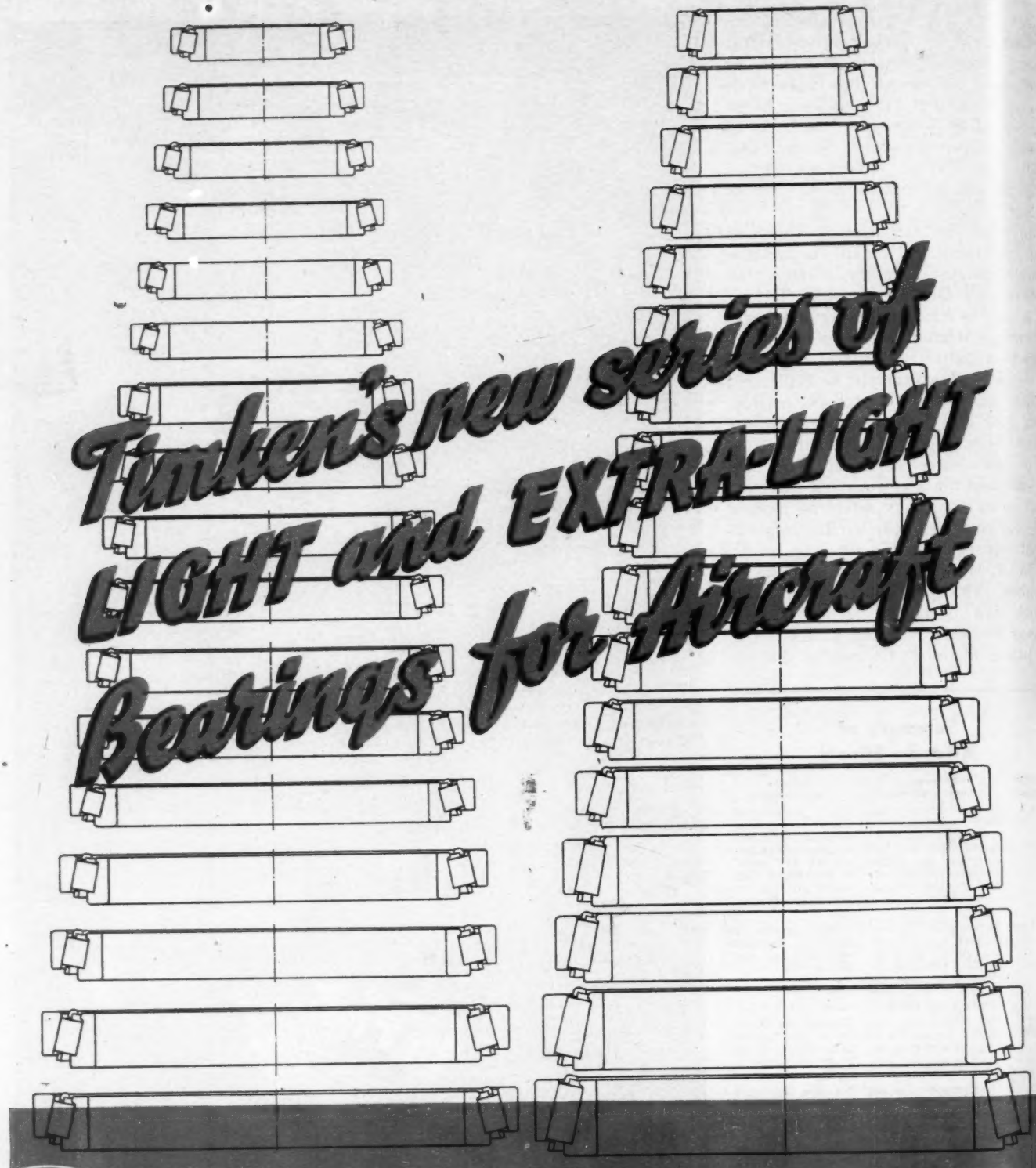
(*Turn to page* 333)

Summary of Altitude Effects

Altitude Range	Bombing Considerations	Defense Considerations
0-330 ft.	Minimum altitude range. Highly effective tactics employable, particularly against mobile land and sea targets. Best weapon is medium and light bomber. Bombing accuracy is excellent.	Highly maneuverable aircraft have best advantages. Multitude of forward firing guns required to "sweep" enemy defenses. Difficult for ground guns to bear on attaching aircraft.
330-3,000 ft.	Beginning of high level bombing range. Minimum altitude tactics not possible. Bombing accuracy is very poor, due to difficult tracking of targets at high speed.	Serious exposure to ground automatic weapons in their most effective range.
3,000-7,000 ft.	Still difficult to track ground targets due to relative speed of plane. Bombing accuracy poor due to this human error.	Exposure to effective fire of light anti-aircraft. Fighter opposition becomes highly effective here.
7,000-15,000 ft.	Most accurate bombing range. Tracking errors slight. Mechanical errors increase steadily from 7,000 ft. but not enough to affect advantage of minimum tracking error. Best policy is to operate as little above 7,000 ft. as possible, compatible with probable losses due to defense.	Beginning of most effective range of heavy anti-aircraft and fighter defense.
15,000-25,000 ft.	Still highly effective bombing range, but mechanical errors increase appreciably.	Unless A-A concentrations are large and elaborate, its effectiveness falls off markedly in this range. Fighter opposition, however, is still highly effective.
Over 25,000 ft.	Fair bombing results possible, but bomb loads must be established and a number of misses are probable. Pattern bombing most effective technique. Bombs can still be confined to relatively small area with precision technique. Desirable altitude where maximum bomb penetration is required.	Generally above effective anti-aircraft range, and fighter performance at this altitude favors the bomber.



Greatest probability of scoring maximum number of hits on target is where each bomber takes sights individually. In attack depicted here, a number of bombers are approaching target from divergent directions and at various altitudes to confuse anti-aircraft and obtain individual runs. After attack they may re-form in formation for mutual protection from enemy fighters. Since each plane is approaching differently with respect to the wind, the bomb release points are different, and possibilities of collision are held to a minimum.



Timken's new series of LIGHT and EXTRA-LIGHT Bearings for Aircraft

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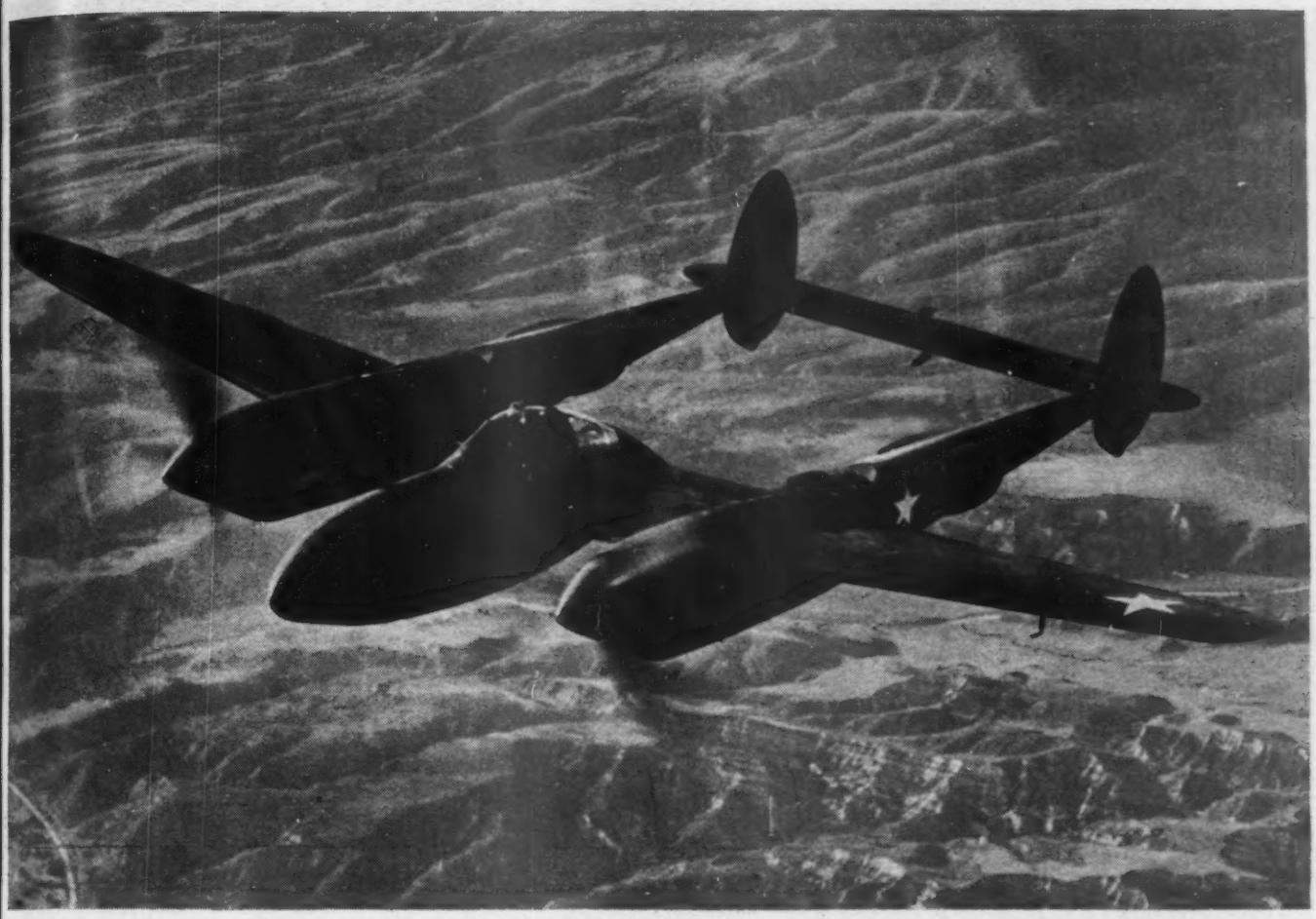


"Lightning" Line Brews Triple Trouble for Axis

By J. H. SREENAN
Works Manager, Lockheed Aircraft Corp.

First complete story of revolutionary mechanized assembly of striking P-38 fighter. New production line has already more than doubled—and may soon triple—output of Lockheed *Lightnings*.

SINCE Jan. 27, 1939, when the prototype of the Lockheed P-38 *Lightning* made its first flight, a record of some sort or other has been achieved that our organization cannot take credit for, other than having precipitated it. I refer to the flaw of controversies that have swirled about this revolutionary fighter plane design.

Combat missions in all theaters of the war have resolved the arguments that raged about the plane's possible performance and characteristics, and another contention is daily being answered in the Lockheed plants.

When the P-38 was first introduced, its design provoked considerable debate as to its probable performance. When this was answered by actual flights, the controversy shifted to whether or not the design could be put into large scale production. This skepticism on the part of production engineers, together with the ever increasing demands of our Air Forces, needled our production staff into evolving many manufacturing systems and methods that are new to the industry.

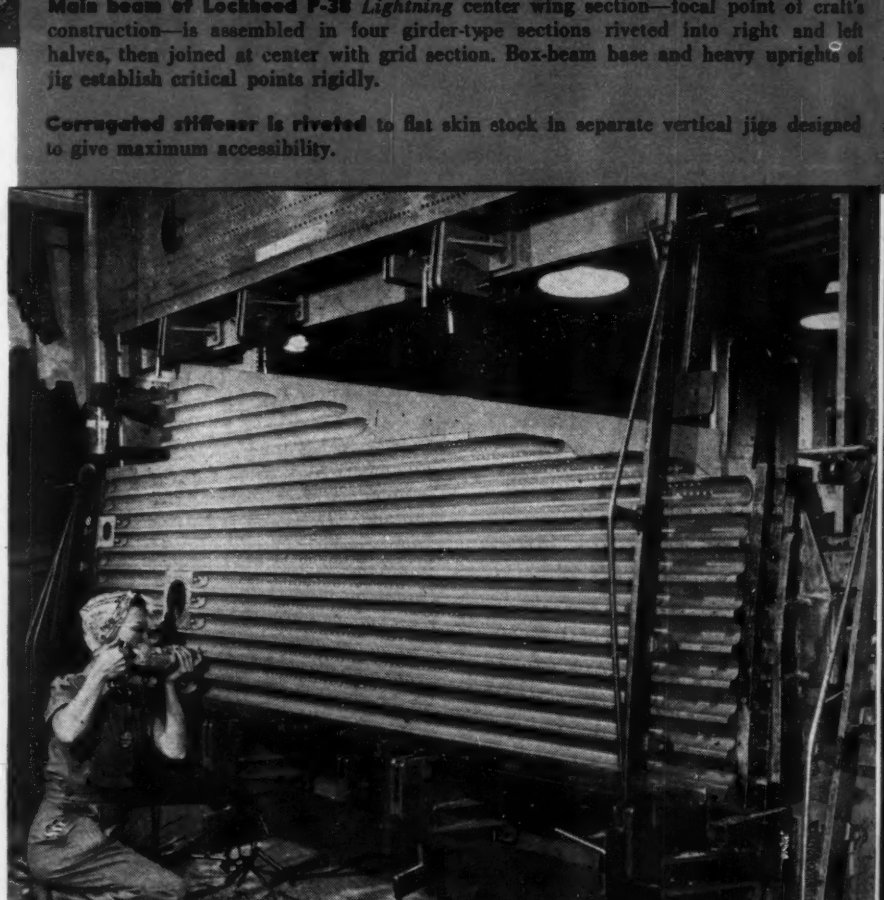
From a production standpoint, it must be readily admitted there were abundant grounds for skepticism. The *Lightning's* design contains more subassemblies than any other fighter type, presenting a really tough problem in coordination. Its more than 30,000 individual parts is about double that of standard type fighter planes. It is more complex, has more compound curves, requires more forgings, more blind riveting, more spot and roll welding, and it contains a considerable amount of stainless steel that presented new forming and welding problems which had to be licked, all of which complicated the production problem.

How well we have solved these problems is attested by the production volume which has already sent hundreds upon hundreds of P-38's to fighting fronts and training centers throughout the world. That volume has just been more than doubled, and may shortly be tripled, both without benefit of plant expansion.

The P-38 has not only been produced

Main beam of Lockheed P-38 *Lightning* **center wing section—focal point of craft's construction—is assembled in four girder-type sections riveted into right and left halves, then joined at center with grid section. Box-beam base and heavy uprights of jig establish critical points rigidly.**

Corrugated stiffener is riveted to flat skin stock in separate vertical jigs designed to give maximum accessibility.



in volume, but is currently being assembled on continuously moving lines with inclusion of many subassembly lines as well as final assembly.

Core of the *Lightning* is the box-like center section of the wing. And major strength of this section stems from the main beam, a slightly V-shaped, girder-like structure made up of four main sub-sections and joined at the center with a grid section. The shear beam detail assembly of the main beam is the heaviest stressed part of the airplane.

Here, at the very start of manufacture is one of the hundreds of bits of ingenuity that, combined, have made it possible to build this plane in "impossible" volume. Machine design engineers created a special 30 ft. long spar miller, with three high-cycle cutting heads, operating in three planes simultaneously, that mills a spar cap 20 ft. long in a matter of minutes where several hours were formerly required.

This beam construction of the center wing section, with its aluminum alloy extrusion caps, has been a handy structure from which to "hang things" and accounts for the P-38's ability to carry 165 gal. droppable gas tanks, or bombs weighing up to 2,000 lb. under each wing. Main and aft beams, assembled in jigs of unusually heavy steel construction, are built up from a box-type

P-38

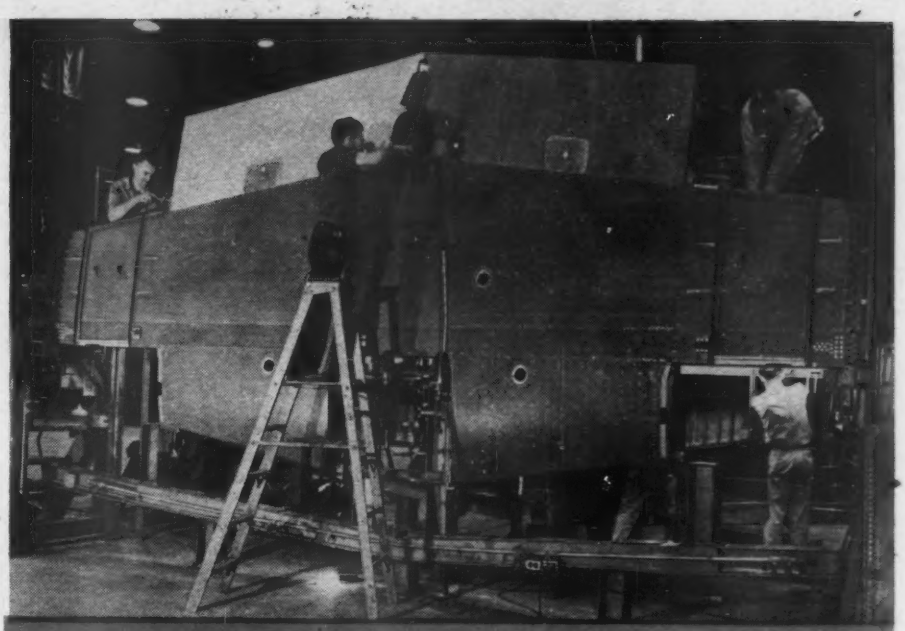
foundation beam anchored to the floor. Uprights establish anchor points and provide alignment plates and template through which bolt and rivet holes are drilled. Both main and aft beams are assembled in jigs of convenient working height, and in the same position they eventually occupy in the plane.

The fore and aft beams are connected by cross-members and to this grid, at the aft beam edge, the pre-assembled trailing edge portion of the center wing section is attached, using jigs which hold the assembly vertical with its leading edge downward. Next, the upper and lower skin assemblies are added, each composed of inner and outer flat stock panels riveted to a corrugated stiffener between them. Such construction reduces the usual number of wing ribs and provides smooth surfaces both inside and outside the wing. This "smooth skin" external surface increases aerodynamic qualities—and manufacturing difficulties. It requires use of 100 deg. angle rivets and exacting riveting techniques.

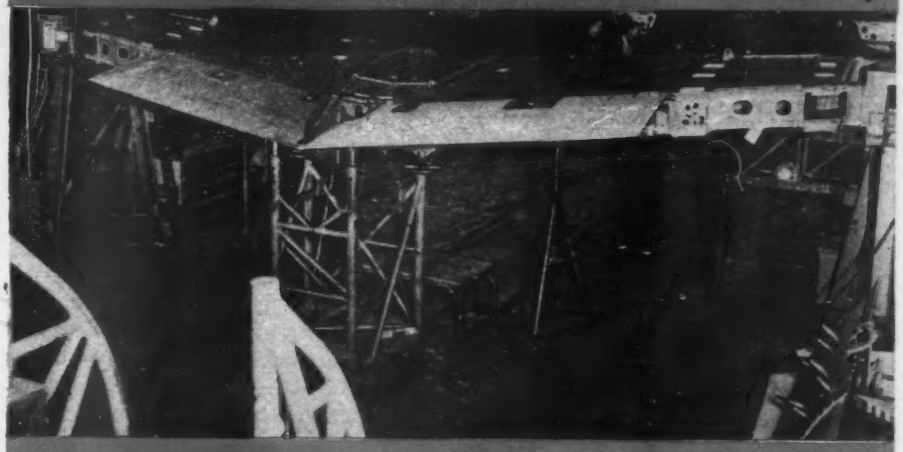
In another jig, the joined center and trailing edge sections acquire tank sections, one on each side of the cockpit floor area. When these sections are joined and pick-up work is completed, the assembly is lifted by traveler crane and placed in normal flight position on a castered height-adjustable dolly, and supported by two adjustable jacks and anchored jigs which attach to brackets later used to fasten outer wing panels in position.

In this working position fuselage and booms are added, the former minus cockpit housing and cowling over the armament compartment and the latter in fore and aft sections, which are joined together after the fore boom sections are attached to the center wing section. Both fuselages and booms are assembled on mechanized lines that are continuously moving as they reach final assembly stages.

Lightning fuselages, though smaller in all ways than standard types, present far more manufacturing problems than

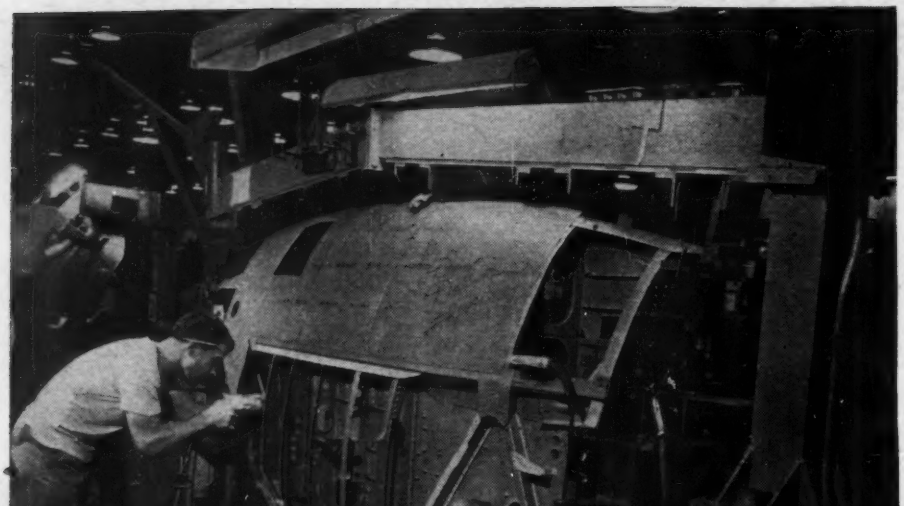


Double-skinned center wing section, with trailing edge and two fuel tank sections in place, gets final touches in last of series of assembly jigs.



Coming from assembly jig, center wing section is placed in flying position on castered stand and held firmly in place by jigs (left and right) attached to outer wing panel brackets. Additional support is provided by jacks placed under main beam. Fuselage and booms are added here, while some parts are coordinated, then removed to be installed later in final assembly.

Fuselage nose, which carries all of *Lightning's* heavy armament, is partially built up, then moved to this "three point suspension" jig to receive initial installations. It is then removed to castered cradle for pick-up work and inspection prior to attachment of skin.



Assembly of structural members and lower skin sections of fuselage side section is completed in this jig, designed to give several working positions.

standard designs because of their small size, shape, smooth skin surface, and high concentration of equipment within them. Because the unusually heavy armament—four 50-cal. machine guns and one 20-mm. cannon—is concentrated in the nose section ahead of the pilot, a considerable portion of this smaller space must be assigned to accommodation of unusually heavy structural members.

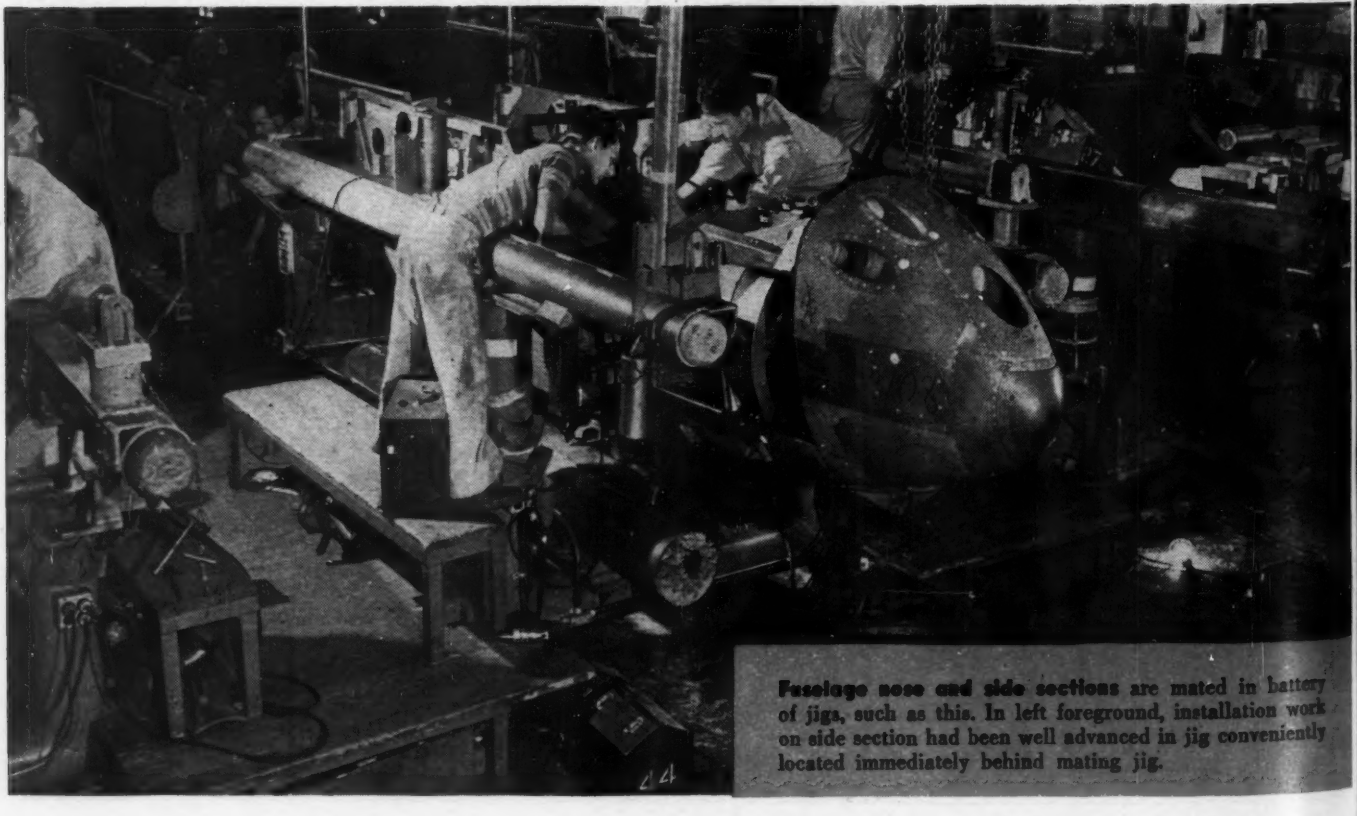
Add the problems posed by doubling of many instruments and controls because of the twin engines, the small space which permits but one workman at a time in the cockpit, and it becomes apparent why it is absolutely necessary to make installations throughout the assembly stages so cockpit requirements will be at a minimum in final assembly.

The nose section is one of eleven major fuselage components and is assembled rather completely before others are joined to it. Pre-assembled structural members are joined in a jig designed to rigidly establish and maintain the highly critical dimensions and so installations can begin there almost as soon as initial structures are joined.

Because of the compactness mentioned above, with resulting inaccessibility becoming more and more acute as the section grows, this and all other assemblies receive the greatest possible amount of installations at each stage of assembly. This number is considerably greater than has been common practice on our lines or those of other producers.

Right and left lower "quarter panels" and structural members of the cockpit sides are pre-assembled separately and joined in indexing jigs designed for maximum convenient working positions. Panels and structural members are equipped with the major part of the tubing, wiring, and other equipment, before being joined to the nose section.

Mating of nose and side sections, which follows panel pick-up work, is achieved in stationary jigs that form another "station" on the line along which flow the nose and side panels. They are merely tacked together in the jig, to save jig time, and then moved



Fuselage nose and side sections are mated in battery of jigs, such as this. In left foreground, installation work on side section had been well advanced in jig conveniently located immediately behind mating jig.

to castered cradles for finish riveting, rigging of more parts, plumbing, electrical equipment, armament blast tubes, armor plate, and installation of the armament compartment floor. While this work is in progress, the cradled fuselage moves through 15 working stations to emerge ready for joining to the center wing section.

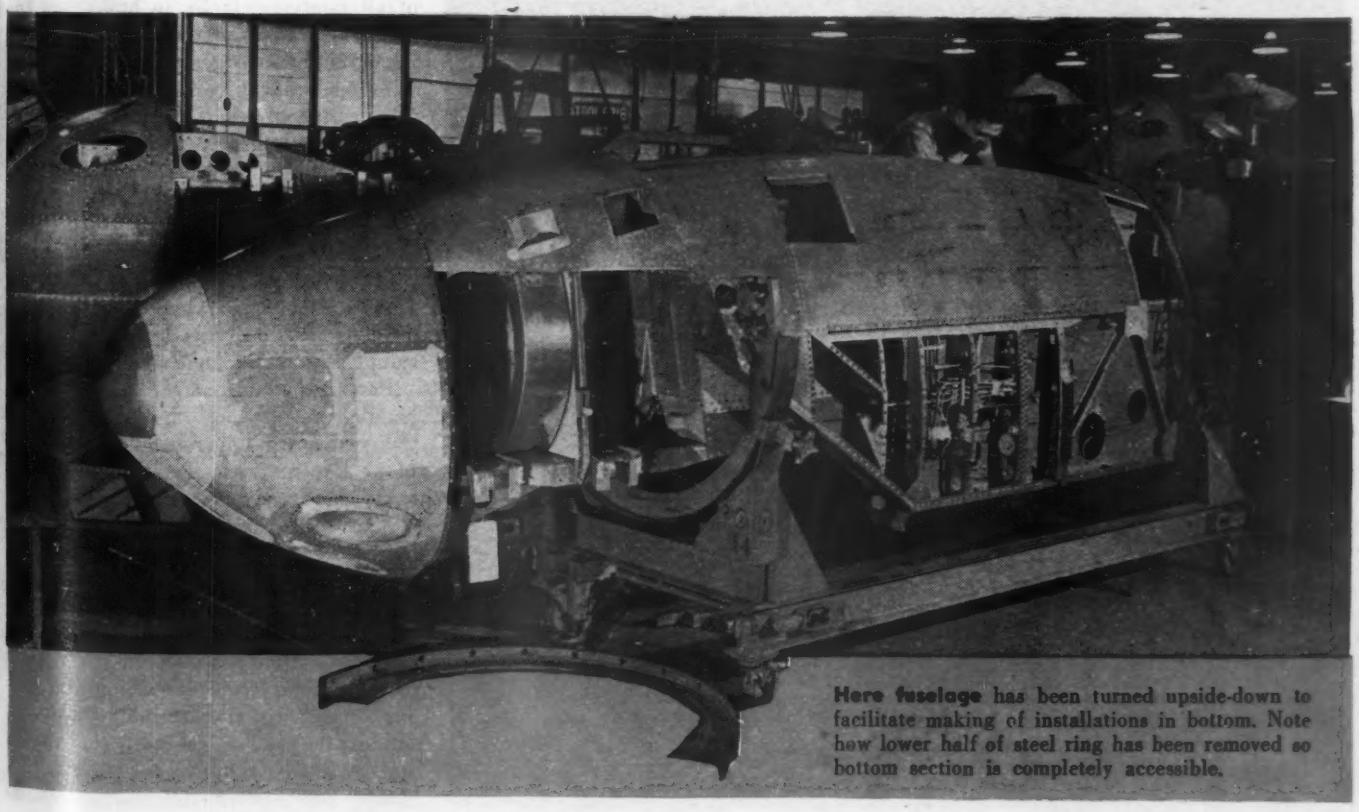
An outstanding feature of these cradles is the indexing design which permits rotation of the assembly for more convenient working positions. Seldom does an assembly remain in a single position while in a given working position or station. Rotation rings are not connected to the cradles, merely revolving in cradle channels, and they are built in two half-section parts for quick removal and replacement affording greater accessibility.

At the end of the fuselage line, a sling is attached to the assembly and it is carried by traveler crane to a position in the pre-mating "reserve" of the body group mating department to await attachment to the center wing section.

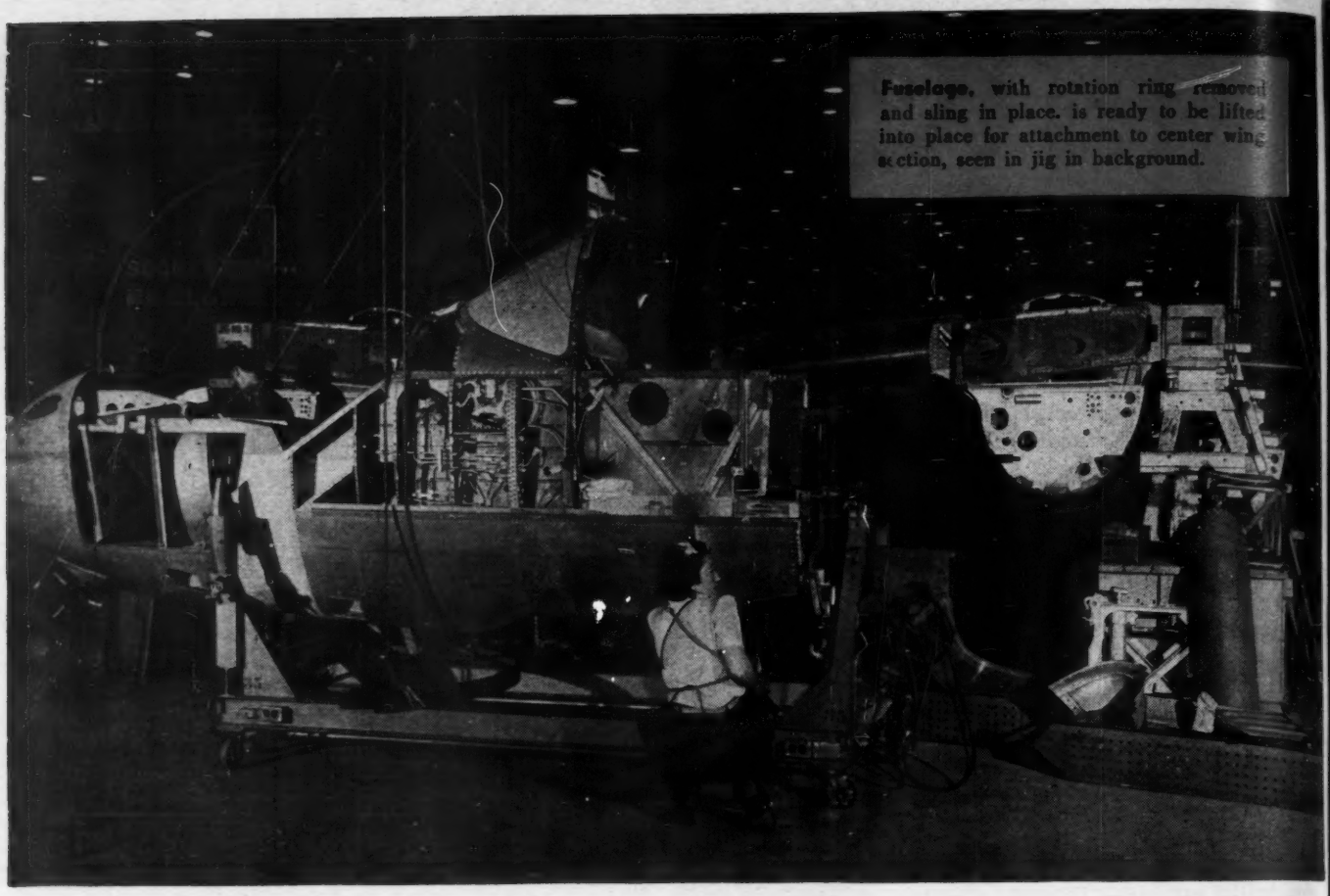
Mated side and nose fuselage sections then move through several stations for finish riveting and completion of installations. Steel ring seen surrounding assembly permits rotation of unit for accessibility. Ring is in two sections, either of which can be removed to get at otherwise inaccessible points.

Right and left booms are assembled in fore and aft sections, the latter being known (because of its shape) as the "hour glass section." These offer difficult manufacturing problems because their strength is achieved through the union of webs, brackets, and skin, the latter butt-joined and, like all other P-38 surfaces, flush riveted. The small interior dimensions and extensive use of stainless steel in the booms further complicate their assembly.

Installations, following the routine used throughout on *Lightning* assembly, are virtually complete inside the boom sections before the fore section is joined



Here fuselage has been turned upside-down to facilitate making of installations in bottom. Note how lower half of steel ring has been removed so bottom section is completely accessible.



Fuselage, with rotation ring removed and sling in place, is ready to be lifted into place for attachment to center wing section, seen in jig in background.

to the center wing section and the aft section is added to the fore section. These include control cables, wiring, the coolant tubing to radiators contained within air scoops mounted on the aft-boom sections near its point of union with the fore-boom section. Stressed throughout, so torque is transmitted through the plane, added strength is gained by cupping the extreme edges

Booms are assembled in fore and aft sections in out-plants, where installations are also virtually completed. Here, fore boom sections are being joined to center wing section, with aft section (right foreground) awaiting attachment to fore section by two-man crew.

P-38

of all lightening holes in bulkheads and brackets. Micarta strips projecting beyond the metal edges provide additional stiffening and give protection against any cutting of cables, wires, and tubing.

Fore sections of the booms are the first joined to the center wing section. Aft booms are then joined and the fuselage follows, in what are called "body mating jigs." There is completion of about one-third of the mating operations in these jigs, so arranged that direction of flow is toward the head of the continuously moving final assembly line.

Parts requiring coordination only are handled in the first mating jigs, then removed and numbered to return to the plane late in final assembly. Hydraulic jacks are used in the mating jigs to offset the drop caused by the constantly increasing additional weight of added components, the jacks being adjusted at successive stages to offset weight increases predetermined through calculations.

Upon completion of mating and joining operations, the assembly (which includes the major part of the empennage) is lifted by traveler crane, and moved to the transfer section at the

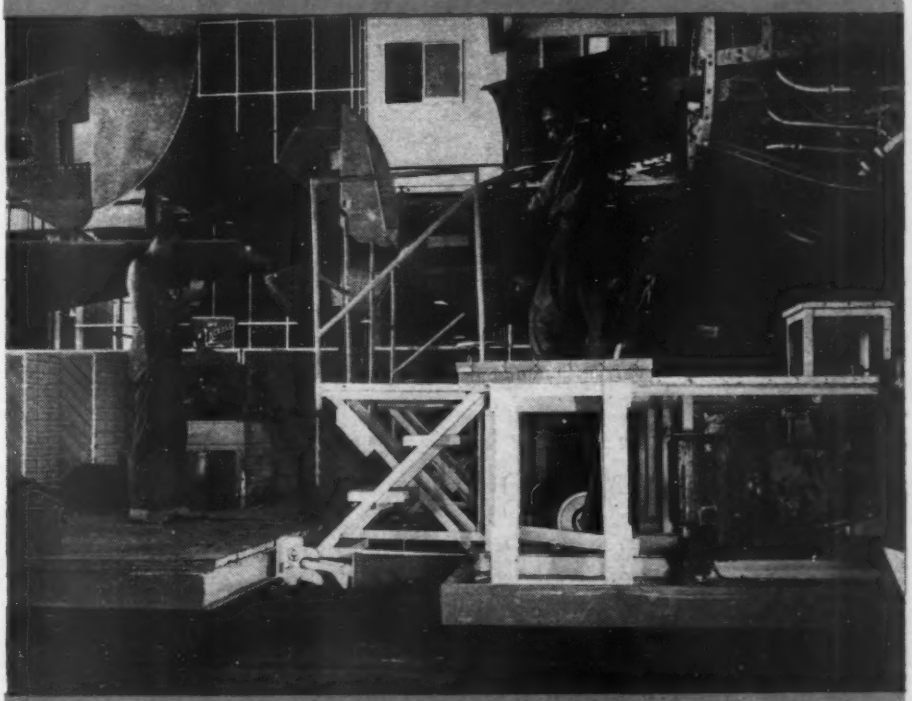
With addition of empennage and completion of pick-up work, fast-growing *Lightning* is moved by overhead crane from body mating line to loading and transfer area at head of first leg of final assembly line, then lowered into position in 8-wheeled carriage. Measuring 20 x 22 ft., carriages provide six working levels. Jacks in center support plane under main beam of center wing section, and padded support above wheel at front of carriage fits under fuselage nose. Wheel adjusts travel of nose jack to compensate for position changes caused by weight of parts added during travel along line. Each carriage pulls 20 x 18 ft. trailer extending under booms, empennage.

head of the first leg of the final assembly line. There it is lowered, in normal flying position, to the final assembly carriage which supports it at three points—under the nose and at two points under the center section on the main beam at about CG.

Base of the carriage is a rectangular I-beam frame carried on eight flanged casters. It is 20 ft. wide and 22 ft. long and pulls a platform trailer 20x18 ft. that provides the working platform under the booms and empennage. Each carriage is equipped with numerous air and electrical outlets and its own transformer for converting 440 v. to 120 v. because of the electrical load required.

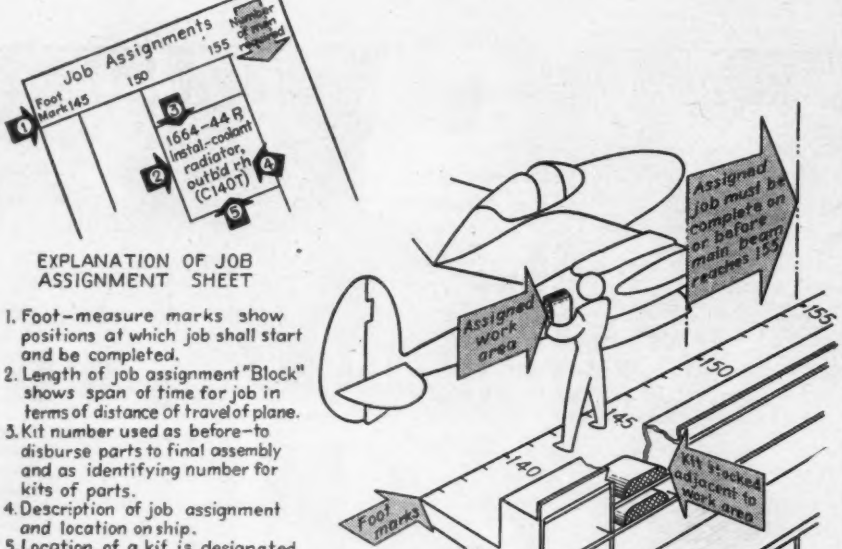
Adjustable nose pads to protect the fuselage nose skin are mounted on a long-travel jack for maintaining desired positions, as more and more weight is added to the plane, and to allow operation of the nose landing gear and check of installations. Removable sections of the carriage floor provide openings required when the main landing gear is added, thus permitting both installation and operation for checking purposes.

Railings around edges of the carriage prevent workers from stepping off accidentally, and six different floor and stand levels provide convenient working heights for all sections of the plane. These range from a bare 6 in. through 10, 12, 25, 40 and 52 in. from the floor. Workers ride on the carriages—cur-



Here, carriage (right) has taken its place on first of three legs of final assembly line and has been coupled to trailer carriage under preceding plane to take its place in "train." Air and electric lines have also been coupled from trailer to carriage.

"Before" (left) and "after" (right) at Lockheed plant, where new mechanized final assembly line has more than doubled, and may soon triple, the output of famed *Lightning*, which has been used for everything from low level bomber-strafing to high altitude fighting or photo-reconnaissance work. Under old system, four lines at right rear merged into two in foreground as outer wing panels were added. New mechanized line, with first


Job Assignments
Foot Mark 145
150
155
Number of men required
1664—44 R instal.-coolant radiator, outbd r/h (C140T)
EXPLANATION OF JOB ASSIGNMENT SHEET
1. Foot-measure marks show positions at which job shall start and be completed.
2. Length of job assignment "Block" shows span of time for job in terms of distance of travel of plane.
3. Kit number used as before—to disburse parts to final assembly and as identifying number for kits of parts.
4. Description of job assignment and location on ship.
5. Location of a kit is designated by a code. Example: (C140T) indicates that the kit will be stocked in side stand "C" at foot mark "140" in top "T" of stand.
Assigned work area
Assigned job must be complete on or before main beam reaches 155
155
150
145
140
Kit stocked adjacent to work area
Foot marks
Side stand C
Stock rack D
18" under stands & racks for tool & lunch boxes

Group leaders are furnished job assignment sheets giving footmarks for beginning and completion of specific job, telling number of workers required, and giving location of stocked "kits of parts" needed for job. Kits are stored in point-of-use bins below platforms and work benches along both sides of assembly lines.

rently at 4 in. per min., but soon to be increased—through the 27 working and inspection stations of the line. Size of the crews "per station" varies from 8 to 16.

Because of the large number of new employees, including a high percentage of women most of whom are without previous factory experience, safety is the keynote of the new line's equipment and installations.

For the first two legs of the three-leg final assembly line, carriages are hooked up as "trains" by couplers that automatically engage when bumped together and which are released by hand. Draglines under the last two planes on the first leg, and under the first two of the second leg, pull the train on the first and push it in the opposite direction on the second. The third leg is powered throughout its length so the craft can

leg seen at left of right photo, moves forward, then carriages are transferred to center line which moves planes backward to another transfer area where they are placed on third leg (extreme right) which moves forward. Note continuous stationary platform, work benches, and storage space at right of first leg. Assembly stations are delineated by marks, in foot measure, starting at 0 on each leg (seen painted on platform).

be moved on the carriages, or without them on their own wheels. Individual tow bars will connect either the carriage or the nose wheel to the drag-line of the third leg, and planes can be mixed there, some on and some off of the carriages, if required. Power trolley and air lines for the first two legs are mounted above the floor and in the floor, and they are covered by hinged steel plates on the third leg.

Transfer areas are located at the ends of the three legs and are used for moving carriages sidewise, on flat steel strips embedded flush with the surface, from the first to the second legs at the door end of the building, and from the second to the third legs at the beginning end. However, when the carriage is not required on the third leg, the plane is lifted off (in the transfer area at the end of the second leg) by traveler crane and placed on its own wheels in position to proceed through the final leg. The carriage is then returned to the loading area at the head of the first leg.

It is in the transfer area, at the head of the first leg, that the partially assembled plane is lifted from a jig in the body group mating department by traveler crane and lowered to the carriage. When fastened to the carriage, the coupler is engaged to the second carriage on the line and the plane begins its trip through the 24 assembly, one checkout, one inspection, and one re-work stations of the line.

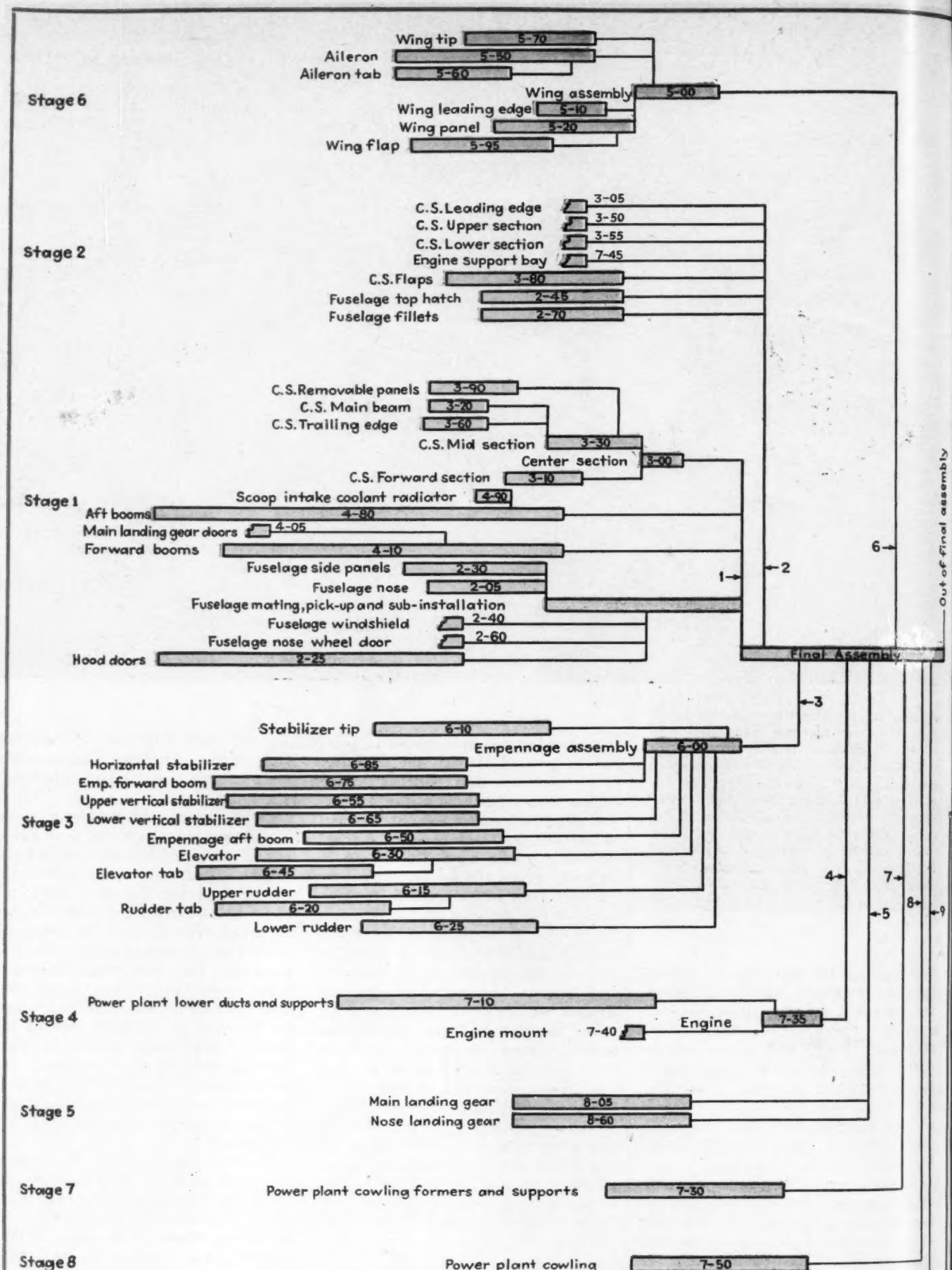
For the first two legs, the carriage passes between continuous platforms, the floor levels of which are 42 in. from the building floor and project toward the plane 18 in. from their supporting bases, providing an "escape" area in case a workman on a lower level of the carriage should find it necessary to get off the carriage at the floor level or has accidentally stepped off at the side. These platforms along the side of the line are flush with the side working levels of the carriages. Clearance between stationary and moving platforms is less than 1 in.

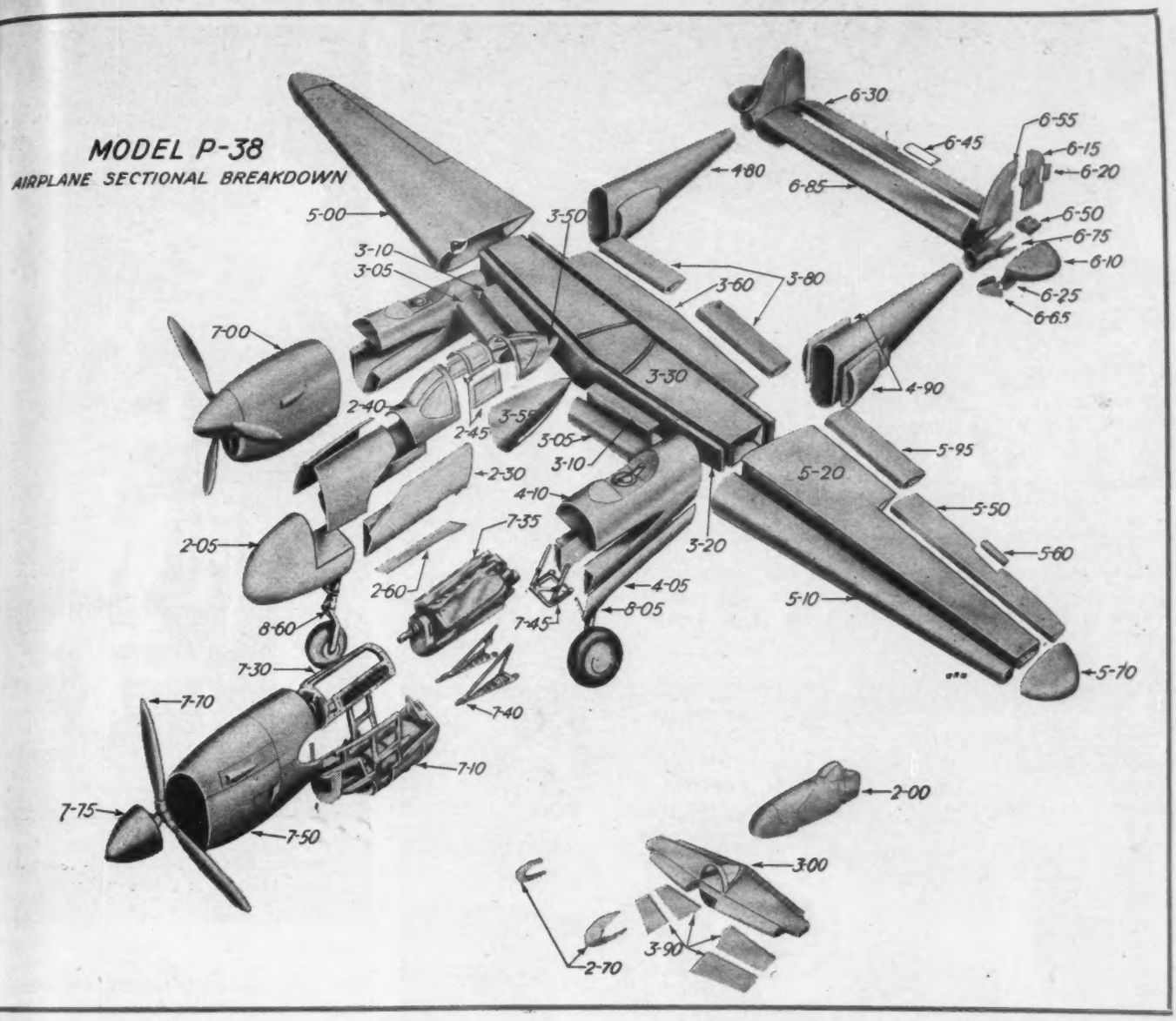
The stationary side platforms are 4½ ft. wide and provide, below their floors, bins of varying sizes for point-of-use storage of parts and tools. At the outside or back edge of these platforms are almost continuous work benches which also provide space for additional point-of-use storage of parts, tools, and materials. Air lines, with frequently spaced outlet points and power conduits for tools to be used at the benches, are provided at the back edge of the benches. Rules forbid workers connecting tools used on the carriages to the bench outlets. They must use utilities connected to the moving carriages, and side-stand workers must use outlets on the benches.

At convenient intervals, the continuous work bench is broken to provide space for 4-ft. wide "magazine type" racks of metal trays for supplies, such as screws, rivets, bolts, nuts, cotters, washers, clips, and coils of small wire. The assortment of such items at each location is selected to meet the requirements of that working area only.

Access to these continuous platforms is from the ends and at 40 ft. intervals throughout their length. At the 40-ft.

P-38


Stage 6
Wing tip 5-70
Aileron 5-50
Aileron tab 5-60
Wing assembly 5-00
Wing leading edge 5-10
Wing panel 5-20
Wing flap 5-95
Stage 2
C.S. Leading edge 3-05
C.S. Upper section 3-50
C.S. Lower section 3-55
Engine support bay 7-45
C.S. Flaps 3-80
Fuselage top hatch 2-45
Fuselage fillets 2-70
Stage 1
C.S. Removable panels 3-90
C.S. Main beam 3-20
C.S. Trailing edge 3-60
C.S. Mid section 3-30
Center section 3-00
C.S. Forward section 3-10
Scoop intake coolant radiator 4-90
Aft booms 4-80
Main landing gear doors 4-05
Forward booms 4-10
Fuselage side panels 2-30
Fuselage nose 2-05
Fuselage mating, pick-up and sub-installation
Fuselage windshield 2-40
Fuselage nose wheel door 2-60
Hood doors 2-25
Final Assembly
Out of final assembly
1
2
3
4
5
6
7
8
9
Stage 3
Stabilizer tip 6-10
Empennage assembly 6-00
Horizontal stabilizer 6-85
Emp. forward boom 6-75
Upper vertical stabilizer 6-55
Lower vertical stabilizer 6-65
Empennage aft boom 6-50
Elevator 6-30
Elevator tab 6-45
Upper rudder 6-15
Rudder tab 6-20
Lower rudder 6-25
Stage 4
Power plant lower ducts and supports 7-10
Engine mount 7-40
Engine 7-35
Stage 5
Main landing gear 8-05
Nose landing gear 8-60
Stage 7
Power plant cowling formers and supports 7-30
Stage 8
Power plant cowling 7-50
Stage 9
Propeller 7-70
Spinner 7-75



"breaks," which are covered by hinged floor boards, ladder-like steps extend down to the building-floor aisle that runs the length of the platform, and beside the steps is space for removable ramps up which heavy testing and greasing equipment is rolled to the stations where it is required. Stationary platforms and the carriages are painted white with the edges of the platforms bearing a 4-in. wide orange stripe to caution workers.

Outside of the continuous stationary platforms, with a 3 ft. aisle between, is a row of 6-ft. high shelving designated as "feeder racks." Beyond these racks is another, wider aisle up which stock is delivered to the feeder racks. Parts are grouped in kits made up from feeder racks and then are moved across the aisle to the point-of-use racks under the floor and bench of the platform.

Previously checked out or assigned kits of parts to be installed on the top levels of the carriages, such as on outboard and tops of booms, cockpit, and other upper sections, are stocked in

shelves beneath the bench. Those to be installed on lower levels, such as lower fuselage, wheel wells, and underside of the wing, are stocked in the shelves below platform floor levels.

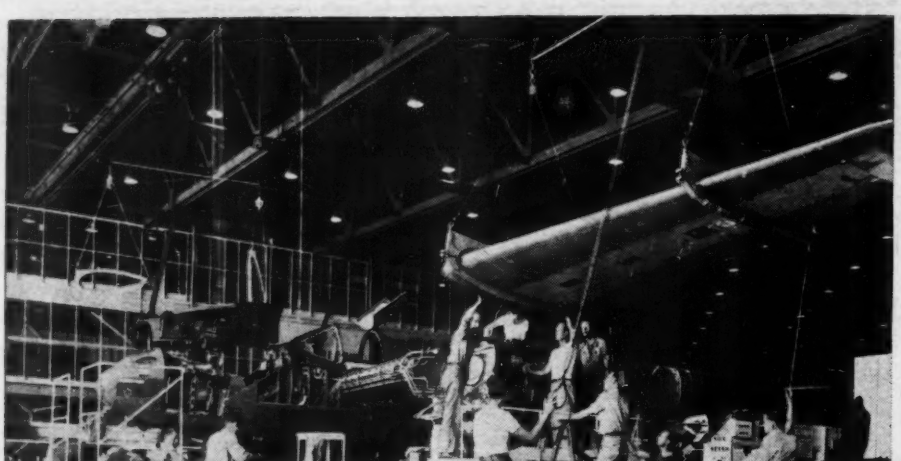
Along the edges of the continuous platforms, measure marks are painted every foot, beginning at 0 at the head of each line and continuing for the full length of the line. At each 5-ft. mark, the figure indicating its distance from the starting 0 is painted in. The main beam of each ship is used as a reference point and as planes pass the footmarks the beam indicates, first, progress of the craft and, second, starting and completion points of assigned jobs.

Group leaders are furnished job assignment sheets giving the footmark at which a job shall start and the mark at which it must be completed, the number of men required for each job, and the location of stocked kits in the adjacent racks. A kit code, for example, listed as "C 140 T" would indicate a kit of parts stocked in rack "C" at footmark "140" in the top tier "T" of stationary racks.

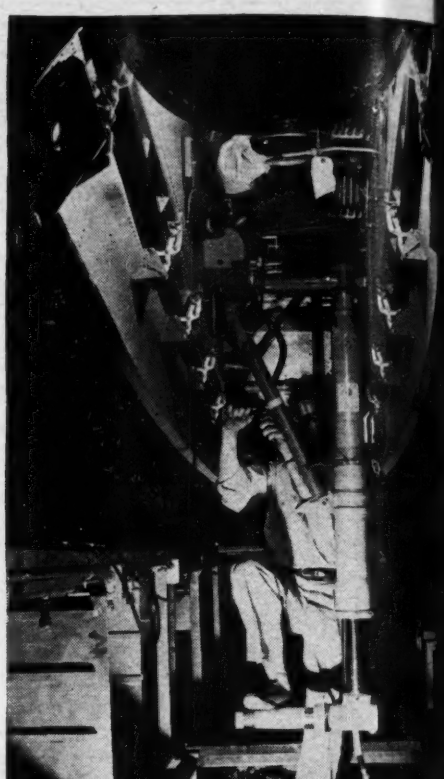
Above the final assembly floor is a system of traveler cranes reaching all areas. And, where required, transfer track links provide means for bringing two of the hoists on to a single crane. It is in slings, after their attachment to these cranes, that outer wing panels are suspended to be given the shake test for loose parts and other foreign matter.

Power for the three chain conveyor units is supplied by a 2-hp. motor using a load of 1.4 hp. to exert 6,000 lb. of push or pull on each line, through a gear reduction from 1,150 rpm. to 0.06 rpm.

Although the space occupied on the line by one plane is designated as a "station," there is no stationized work



Outer wing panels are given "shake test" while in sling attached to overhead crane, which moves them from storage area to final assembly. Here, outer wing panel is swung into position as plane starts moving backward on second leg of final assembly line.



Section of carriage floor is removed to facilitate landing gear installation.

Pick-up and hook-up operations are performed on second leg of final assembly. Workman in foreground rides on carriage while working on empennage, while employee below wing of succeeding plane works from continuous stationary platform at side of line. Footmarks to delineate stations along line are clearly visible here. Note low side bench to give safe clearance from overhanging wing.

area. Group leaders' assignment sheets indicate the starting footmark and the point of completion. If, owing to the nature of the job, it is impossible or impractical to make a definite break in a job between work areas, the crew continues through following stations until it is complete. This is especially true of rigging and check-out operations. If, due to changing shifts, one crew turns over an incomplete assignment to another, the completion footmark is the important point to the second crew.

All jobs have specified starting places and must be completed in the distance allowed. This may mean that some operators perform more than one job while others do only part of a longer operation. Special pick-up crews handle make-up or re-work jobs at the earliest possible moment, to avoid having such work accumulate into a "jam" that might force a plane out of the line-up, or necessitate halting the line.

Typical of a long-cycle, multi-man operation is the main beam rigging, a job on which a five-man crew works through two stations and installs the parts in seven kits. After listing the kit numbers and stipulating that a five-man crew be used, the assignment

sheet gives these instructions:

"1st man using Kits 22 L and 23 L does outer beam and boom work.

"2nd man using Kit 20 L does LH. lower fuselage and inner beam work.

"3rd man using Kit 21 does cockpit work.

"4th man using Kit 20 R does RH. lower fuselage and inner beam work.

"5th man using Kits 22 R and 23 R does RH. outer beam and boom work.

"All surface control and coolant shutter cable systems are to be brought to tension. All brackets are to be completed. Due to the complexity and length of this operation the five men are to work through Station 1642 on same ship. This will require a second crew of five men to work on the following ship. (By the time a third ship is in the line, the original crew will be available to take it over.)"

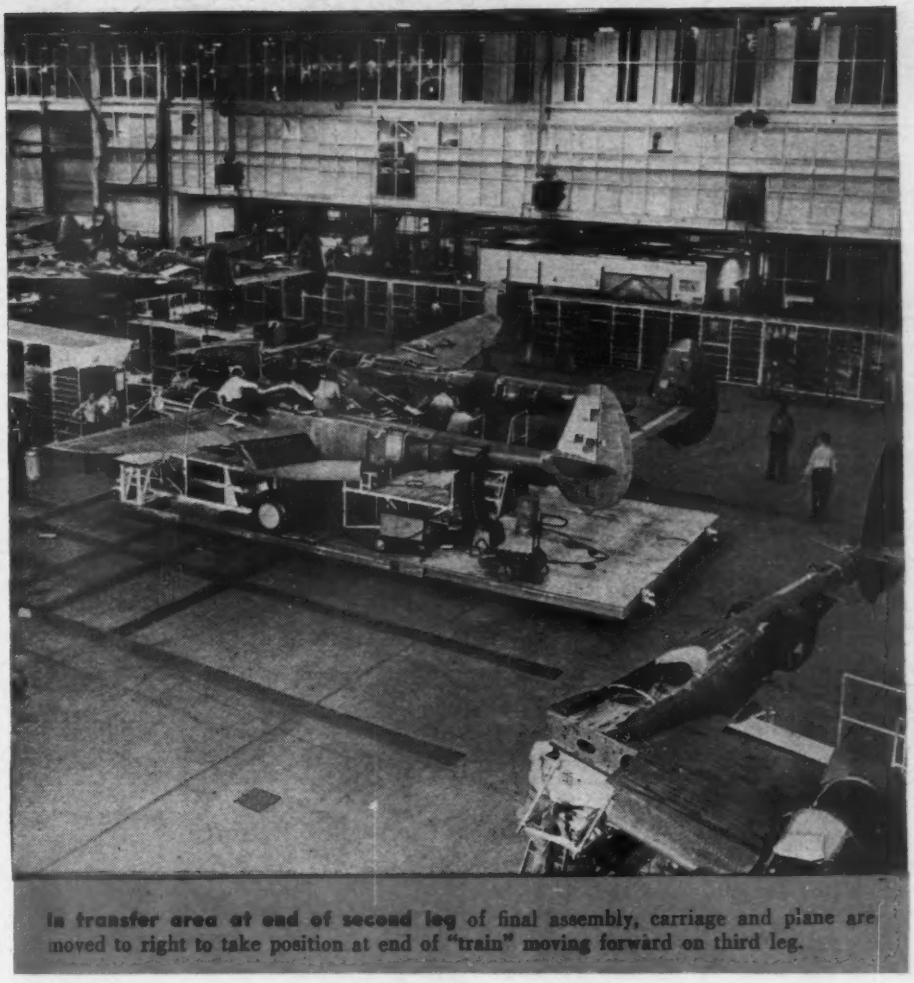
In the first station of the first leg, 22 jobs are assigned. Of that number three carry over to the next station where they are completed, but jobs which follow them do not finish and carry over to the third station. Sixteen jobs are assigned to the second station and 26 to the third. The average per-station throughout the first leg's nine stations is 16. On the second leg the average is 17 and on the third, 12. Three of the final leg's stations are devoted to check-out, inspection, and "squawks," this accounting for the low average of per-station job assignments.

At the beginning of the second leg outer wing panels are hung, in the first station. Engines are installed in the second station. They arrive from a mechanized dress-up line paralleling the second leg, but flowing in the opposite direction and reaching a close proximity to the installation point on the second leg.

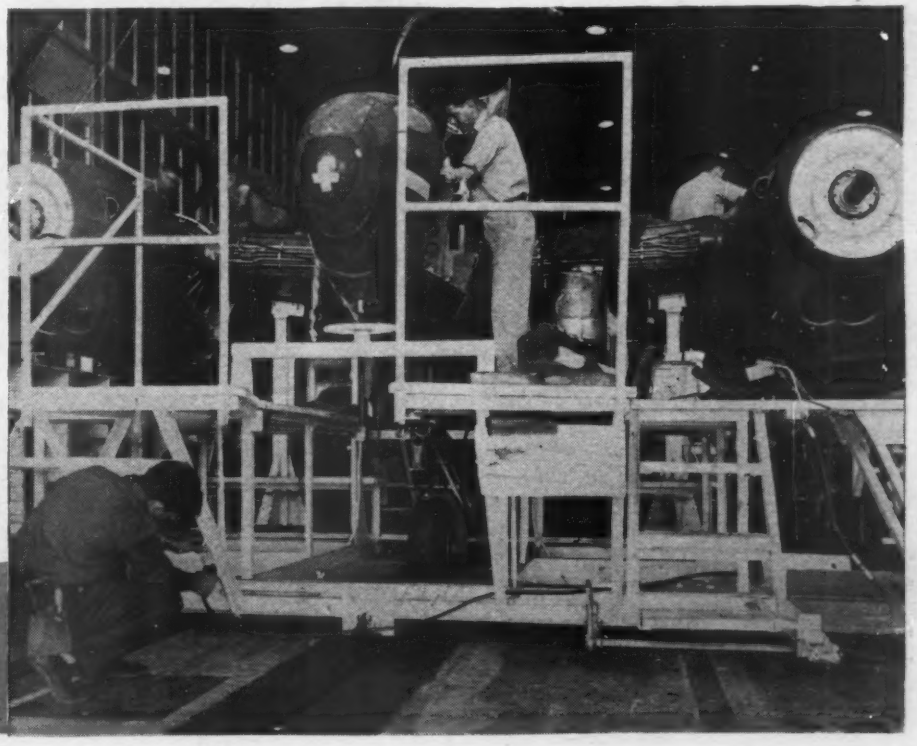
Typical of the job assignment per-station is that of "Station 1642," which has 16 jobs, or the average on the first leg of the line. As listed in the *Job & Procedure Manual* they are:

1. Main Beam Rigging—Continued. Original 5-man crew accompanies ship into Station 1642 and finishes rigging as described in 1641. (All surface control and coolant shutter cable systems are to be brought to tension. All brackets are to be completed.) Since this work will be completed prior to the end of the station interval, the five men will work at the following minor jobs before picking up a new ship at the end of the station interval.

2. LH. Oxygen Bottle Support—Kit 1642-41L. This job includes installation of the support on the aft side of the 265 boom bulkhead and installation of wire assembly No. 196224 which



In transfer area at end of second leg of final assembly, carriage and plane are moved to right to take position at end of "train" moving forward on third leg.



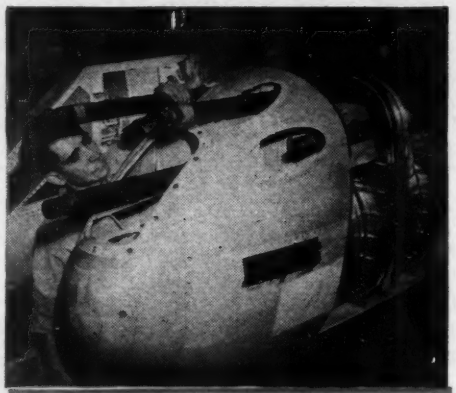
With tow bar engaged to drag-line beneath slot in floor and carriage moving along third leg of final assembly, workman connects electric cable from underfloor trolley.

Off end of third leg of final assembly, another *Lightning* is lifted from carriage, which will be returned to beginning of first leg by tractor.

runs through bulkhead 265 from its "J" box on the forward side and clips to the outboard flange of the oxygen bottle support. Two men are required: One in the manhole of the aft boom and one in the aft portion of the forward boom well.

3. RH. Oxygen Bottle Support. This job is assisting another man install the RH. support. Refer to Item 4.

4. RH. Oxygen Bottle Support—Kit 1642 41R. Before installing support on aft side of 265 bulkhead it will be necessary to loosen "J" box on forward side of bulkhead to secure access to the bottom three outboard screws. When support is secure the "J" box must



Rolled on its own wheels from final assembly line to armament section, P-38 gets last of four 50-cal. machine guns and harder-hitting cannon.

P-38

be replaced. Job requires assistance of second man above.

5. Rig Fuel Selector—Kit 1642-26. Install all parts (pulleys, fairleads, cables, etc.) and connect turn-barrels. (Tensioning and selling to be done in 1643.) See Item 2 of 1641 and Item 2 of 1643.

6. Complete and Sell Push-Pull Tube, LH. Roller brackets are to be adjusted and safetied. Complete installation is to be made upon the push-pull tube. Job is to be sold to inspection.

7. Complete & Sell Push-Pull Tube, RH. See item 6.

8. Drop Tank Plumbing—1642-31L. The job consists of installing the fuel line that goes from the main beam fitting to the lower tail cone and the fuel line through the main beam to the front tank area.

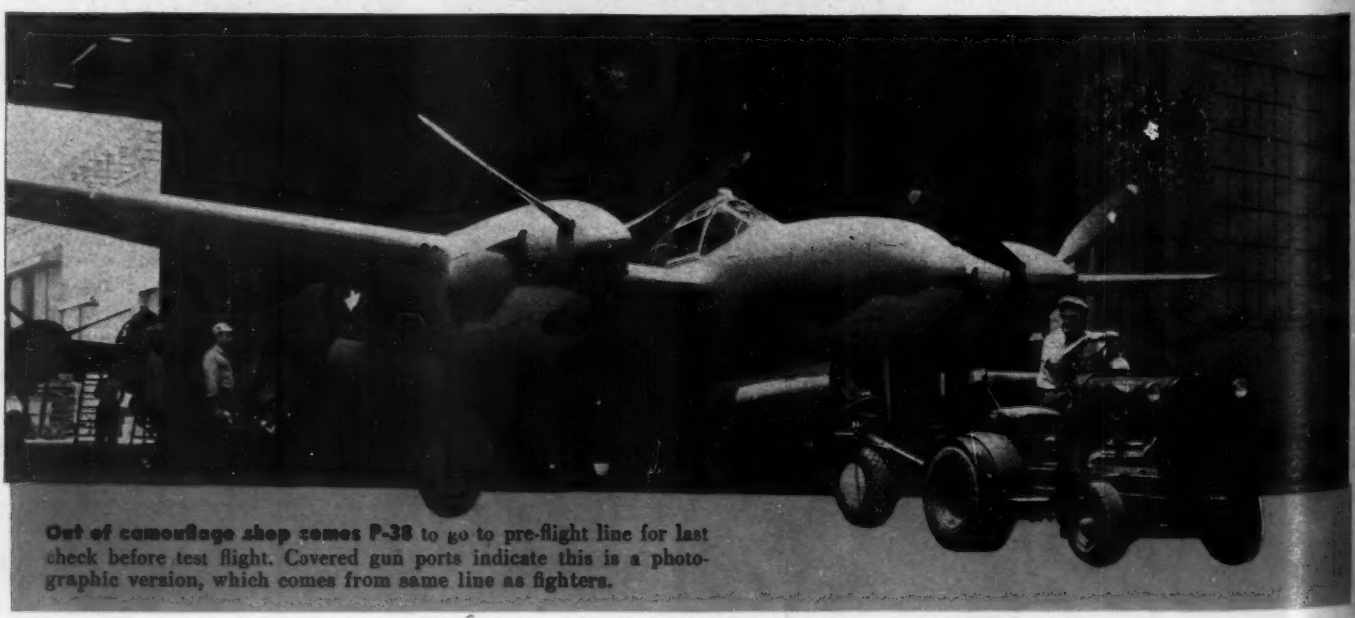
9. Shear Beam Plumbing LH. (assist). This job consists of assisting another man to install the LH. front shear beam assembly. See item 12.

10. Coolant Vent LH. 1642-42. The coolant vent tube is to be inserted in place. It will not be clipped to any structure until the stainless steel baffle is installed.

11. Install LH. Supercharger 1642-49L. The supercharger well is to be cleaned and sold to inspection. Secure the assistance of the other supercharger installer to drop the supercharger in place. Complete and sell the installation.

12. Shearbeam Plumbing-LH. 1642-20L. This job consists of ball checking

(*Turn to page* 309)



Out of camouflage shop comes P-38 to go to pre-flight line for last check before test flight. Covered gun ports indicate this is a photographic version, which comes from same line as fighters.

The B.F. Goodrich Airplane of the month

CONSOLIDATED PB2Y-3

FIRST TO SPOT AND CONTACT the enemy in many a sea battle are these great patrol bombers of the U. S. Navy which operate thousands of miles out ahead of the fleet. Popularly called the Coronado, the PB2Y-3, built by Consolidated Vultee Aircraft Corporation, is the largest and most powerful mass production airplane in Navy service.

B. F. Goodrich equipment helps the Coronado perform its vital tasks with greater safety and efficiency. De-Icers, for example, crack off dangerous ice when it forms on wing and tail surfaces. And in the thick of battle, B. F. Goodrich Bullet-Sealing Fuel-Cells cut the hazard of gasoline leakage and explosion.

To the men who fly them, a nation's praise and gratitude. To the plane itself, a salute, and our nomination as "Plane of the Month."

In war or peace

B.F.Goodrich

FIRST IN RUBBER

B.F. GOODRICH RUBBER RESEARCH FOR THE *Aviation industry*

A MACHINE GUN SLUG made the gaping hole shown at right . . . a slug ripping out through a fighter plane's fuel tank. And this jagged hole—called a "flower" by technical men—would have written a flaming finis to a fighter pilot's life if it had been made just a few years ago. For then, gasoline would have poured through . . . ignited . . . !

Today it's different . . . with *our* planes at least. Our fliers cheat death time and again because *their* fuel reservoirs can take it. They can be pierced by 30's, 50's, even 20-mm. cannon shells . . . "flowers" can bloom all over their outside surfaces . . . but the bullet-sealing *inside* lining holds.

On this "inside lining" hangs a tale . . . a story of research and development that B. F. Goodrich had a large part in writing. It starts back in World War I when engineers first attempted to make fuel tanks self-sealing. Some initial success was achieved by covering the *outside* of a regular tank with rubber compounds and then covering the rubber with a protective layer of leather. But as the power of gunfire increased, the outside covering method lost its effectiveness. Bullets passing through would force out jagged "flowers" on the exit side and rip off large sections of the covering—making self-sealing impossible.

B. F. Goodrich engineers were first to work out a practical solution to this "flowering" problem. They lined a tank instead of covering it, and in so doing made the forerunner of the bullet-sealing fuel cell most commonly used today. The schematic drawings on the opposite page show why the inside lining works where the outside covering failed.

The development of the leak-proof tank insert is just one of many contributions B. F. Goodrich has made. Our engineers have done extensive work in compounding improved sealant materials. They have supplied linings and sealants that function satisfactorily in contact with aromatic fuels which tend to dissolve ordinary materials. They have devised special forms on which to build fuel tanks, which can be made up in all of the great variety of complex shapes required. They developed synthetic rubber molded connections and effective adhesives for use in fuel-cell constructions. They constructed self-sealing hose to assure safe transmission of the fuel from the fuel tank to the airplane's engines.

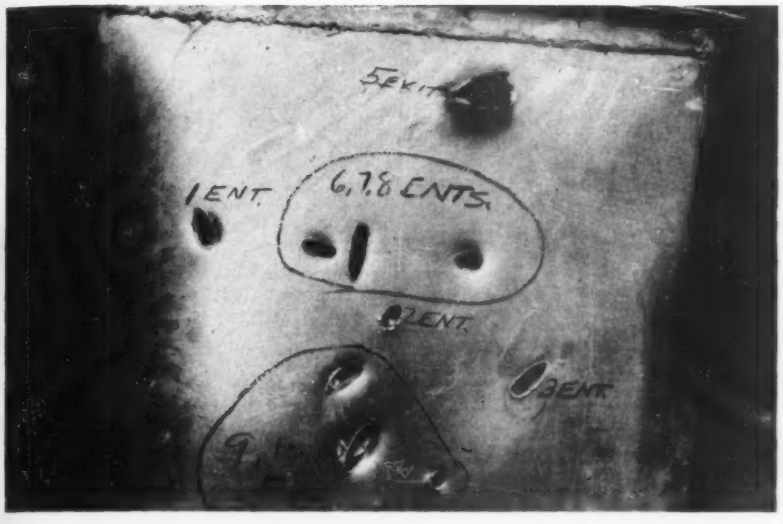
MAKERS OF B. F. GOODRICH TIRES AND OVER 80 RUBBER AND SYNTHETIC RUBBER PRODUCTS FOR AIRPLANES

ARMY E NAVY

Awarded to seven plants

Firing tests prove fuel cells can take it

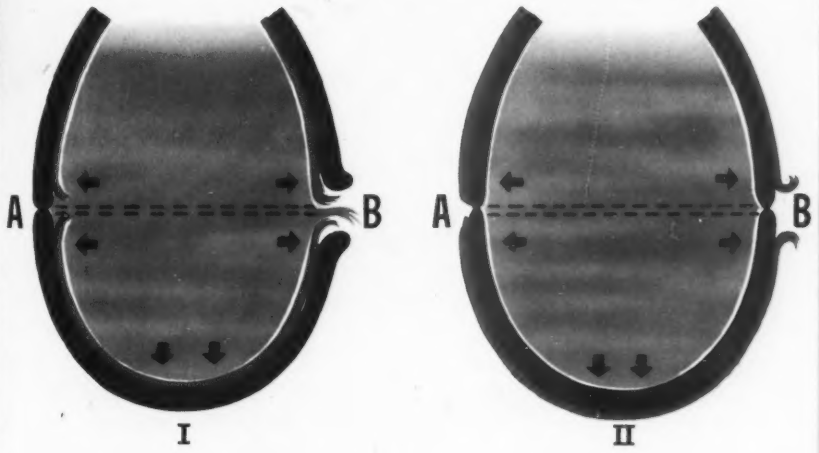
BEFORE THEY TAKE OFF !



Every combat condition is simulated in these tests...

Machine gun bullets—both 30's and 50's—incendiaries, and cannon shells are fired at test tanks filled with gasoline. Shot after shot is pumped into them from all angles to see how much they can take without leaking or exploding. Bullets are even ricochetted into the tanks to simulate deflection from a strut, propeller or some other part of the plane under fire. And these tests prove that tanks with B. F. Goodrich bullet-sealing inserts can absorb the terrific punishment necessary to bring our planes back after sky battles against overwhelming odds.

How "flowering" was licked with B. F. Goodrich bullet-sealing inserts

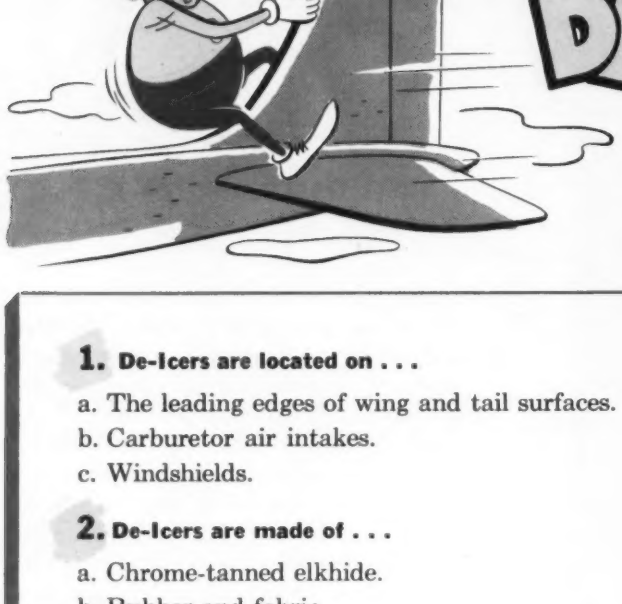


The two schematic cross-section drawings above show what happens when high-power bullets pierce the old-type covered tank and the modern "lined" tank. Bullet enters at (A) and exits at (B) in both; arrows indicate pressure direction. In sketch I (old type) fuel rushing out of (A) under pressure forces covering from side of tank, thus retarding self-sealing there. At (B) the terrific force causes the metal to flower, ripping a big jagged hole in the covering and stripping it off the outside. Obviously, sealing is impossible. In sketch II (modern type) the pressure exerted at (A) holds the insert tight against the metal tank and prevents separation. At (B) pressure again holds the insert tight against the tank; thus the bullet makes a cleaner hole in insert, and the flowering, being outside, is harmless.

In war or peace

B.F.Goodrich

FIRST IN RUBBER



PRIVATE GEORGIE GREMLIN SCORED 0 ON THIS

DE-ICER QUIZ

CAN YOU SCORE 100%?

Complete the ten statements by simply picking the one correct part (a, b or c) following each numbered statement. See if you can get them all.

1. De-Icers are located on . . .

a. The leading edges of wing and tail surfaces.
b. Carburetor air intakes.
c. Windshields.

2. De-Icers are made of . . .

a. Chrome-tanned elkhide.
b. Rubber and fabric.
c. Specially rolled 88-gauge aluminum alloy.

3. Each De-Icer contains . . .

a. Central tube area flanked on top and bottom by elastic stretch areas.
b. An electric heating unit encased in rubber.
c. Perforated layers of metal-reinforced leather.

4. De-Icers are operated by . . .

a. Super-heated oil at 10 lb. per sq. in. internal pressure.
b. Air.
c. Alcohol and carbon tetrachloride.

5. A De-Icer's tubes pulsate in order to . . .

a. Keep rubber from freezing.
b. Keep ice from forming.
c. Crack off ice after it forms.

6. Aluminum fairing strips are used in De-Icer installations . . .

a. To drain static electricity from De-Icer surface.
b. Because brass is not obtainable.
c. To streamline the De-Icer attachment and to act as a washer strip for the attachment screws.

7. De-Icers are attached with . . .

a. Rivnuts and screws.
b. Rivets.
c. Zoot nuts.

8. Metal end strips are used to . . .

a. Cut down wing flutter.
b. Prevent endwise creep or movement of the De-Icer.
c. To restrict tube inflation.

9. The outer surface of De-Icers is covered with a special conductive coating which . . .

a. Sets up anti-magnetic waves.
b. Bleeds off static charges that might cause punctures and explosions.
c. Cuts down air friction.

10. The rows of small vent holes in the top and bottom elastic areas are placed there to . . .

a. Trap wing-boring gremlins.
b. Cool the De-Icer system when it is not in use.
c. Facilitate movement during inflation and aid in keeping the deflated De-Icer tight against the wing.

WHAT IS YOUR SCORE?

Each correct answer counts 10. 1-a, 2-b, 3-a, 4-b, 5-c, 6-c, 7-a, 8-b, 9-b, 10-c.

This is one of a series of maintenance quizzes prepared for ground crew trainees of the U. S. Army Air Forces Technical Training Command. It is our hope that this series will help all maintenance men get maximum service, safety, and efficiency from military, commercial, and civilian aviation equipment.

B. F. GOODRICH, AERONAUTICAL DIVISION, AKRON, O.

Skyway or Highway

B.F.Goodrich

FIRST IN RUBBER

Design Approach For Long Range Aircraft

Part I

By **ROBERT V. BONAME,** *American Export Airlines*

A method leading to the optimum combination of values — to be assigned to wing and power loadings and other aerodynamic characteristics — an airplane intended for long range service.

SINCE THE WHOLE QUESTION of long range flying technique is one of the most complicated in aeronautics, it would seem advisable to clarify as much as possible the interdependence of the different factors involved in the design of long range aircraft. There follows here an outline of a method which will lead to the optimum combination of values, to be assigned to wing loadings, power loadings, and other principal aerodynamic characteristics, in the development of a ship intended for a particular distance service.

Apart from fundamental design considerations, the financial importance of the projects of tomorrow, such as the 200,000- to 300,000-lb. flying boats already under consideration, justifies and demands some definite solution to the problems which would eliminate—or at least check up on—the factors still dependent upon personal judgment and intuition.

Having thus defined the essential purpose of the method we are about to propose, there remains this dual question to be answered: On what general and technical bases shall the design be developed?

Our answer is, first, that we shall consider the problem from a commercial—that is, business—point of view and in the light of pre-war activity, enhanced by all we hear or would like to hear about air carrier possibilities.

In this respect, it is perhaps pertinent to recall that, although war conditions have more or less disrupted business procedure, when we have a return to peacetime economy, profit and loss will again become major considerations. A ship should, therefore, be designed primarily to be profitable from the point of view of the operator.

Such technical aspect of the problem as tonnage, speed, and altitude, which so often absorb the designer, interest the operator only as they are translated into terms of useful load carried per unit of operating cost.

With this idea as a starting point, the first step should be to make a thorough survey of the field to be exploited. Such an analysis would determine the best types of service to consider, whether for transport of cargo alone, of mail alone, of passengers alone, or of combinations of these elements and if so in what proportion.

Such factors, together with the probable schedule of flights, would indicate in quantity and quality the amount of load to be taken on each trip and at the same time outline the general size and main transport features of the plane to be considered.

As a fundamental parameter for optimum design, some operators would choose gross weight. The best solution, for them, would consist in determining an "optimum gross weight", the value of which would offer the best ratio $\frac{W_p}{W}$ of payload to total tonnage. Others might think of efficiency in terms of necessary horsepower, and for them the best solution would depend upon the "optimum power" corresponding to the best ratio $\frac{W_p}{bhp}$ of payload to total horsepower. Others, finally, might want to be theoretically more precise, hence would choose the best solution on the basis of some complicated formula taking into consideration simultaneously all the principal factors involved: Gross weight, power, and speed, each appearing with its respective coefficient of merit.

These different methods are all more or less justifiable on paper, but for anyone familiar with the practical field of air transportation it is apparent that, during a given period and for similar types of air service over similar routes, the gross weight has an almost standard value imposed chiefly by operation requirements.

In other words, the various requirements of successful operation, such as those pertaining to safety characteristics and comfort of the passengers and flying personnel—performance with an inoperative engine, duplication of vital instruments and accessories, composition and rotation of crew members, accommodation required for the average number of passengers, and necessary space for normal cargo load, etc.—determine fairly precisely the necessary size and gross weight of the plane under consideration, the resultant figure varying only with the technique of the moment.

Furthermore, since aircraft technique is now developing by progressive evolution rather than revolutionary innovations, we can safely assume that an experienced technician, aware of the trends, will have no difficulty in estimating within a safe margin of error the general type and gross weight of a ship which would be capable of carrying a specified payload over a given route.

It therefore seems reasonable to choose the gross weight as a predeterminable basis for the design of the ship to be built. What then becomes important—and this is the main object

The *Mars* taking off. In the near future most of the world's luxury trade will be carried by huge flying boats.

of the present discussion—is to make sure that the aircraft of such gross weight as may be assigned, will, upon completion, be able to carry at least the payload expected by the contractor and as much more as possible.

It should be noted that this result can be obtained even when some error has been made in the initial estimate of the gross weight. It is indeed known in mathematics that a function varies but slightly in the neighborhood of its maximum, so that even if we consider the payload as a function of the gross weight, the error which may have been made, relative to the optimum value of this latter, will not appreciably affect the maximum payload in which we are interested.

Let us also add, in answer to the objection which might be raised that speed and power do not appear as initial and basic factors along with gross weight, that the method we propose also furnishes all the necessary graphs for establishing whatever compromise solution may be desired.

Having these diverse considerations in mind, we can now undertake to find that combination of design characteristics which will afford the optimum value for the disposable load, represented of course by the maximum difference between the gross weight on the one hand and the weight of the plane structure and necessary fuel on the other.

Such is the principal method of this study, which we will first expose in a general way, outlining the theoretical aspects involved and then apply to a numeric example, closing with a discussion of certain factors involved.

The new element in our method consists in the grouping of the system of equations which govern flight conditions, together with an equation of structural weight, and solving them so as to obtain the necessary characteristics for an optimum disposable load, as stated above.

We shall introduce each equation with an outline of the conditions governing it.

I. The first equation is based on the formula for maximum range as presented by Louis Breguet in 1927,[1] on the basis of the aerodynamic theories of the French scientist Rateau[2].

$$R = 862.5 \cdot \frac{L}{D} \cdot \frac{\eta}{c} \cdot \log_{10}\left(\frac{W}{W - W_f}\right)$$

where R is the range in statute miles by calm air;

L/D the lift over drag ratio at the average angle of attack used during the flight;

η the average propeller efficiency;

c the average specific fuel consumption;

W and W_f the gross weight of the plane at take off and the load of fuel taken on board, respectively.

(1) Communication to the French Academy of Sciences, May 16, 1927.
(2) Communication to the French Academy of Sciences, Feb. 16, 1920.

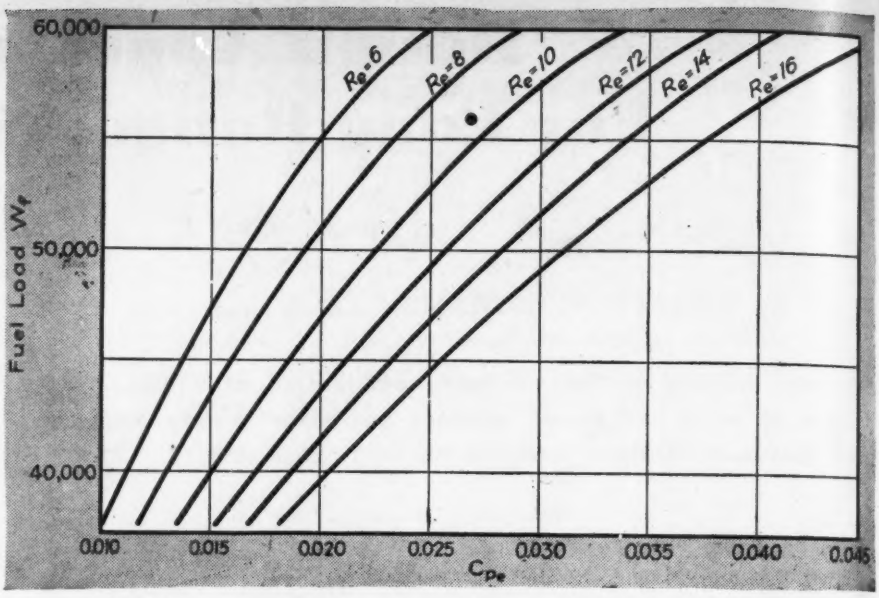


Fig. 1. Necessary fuel load W_f vs. minimum parasite drag coefficient C_{p_e} for different values of aspect ratio R_e.

It should be born in mind however, that this equation is drawn up on the assumption that the L/D ratio remain constant, that is, that the flight be made at constant angle of attack.

Since it is apparent from this equation that, other things being equal, maximum range or maximum payload on a given range will be obtained when flying at, or in the immediate neighborhood of, the maximum value of L/D, will suppose from now on that the plane will be constantly flown at this angle of attack and that all design characteristics will be subordinated to that condition.

This means, as can be easily proved theoretically, that if the flight is accomplished at a given altitude, the power used decreases as the square root of the gross weight, which of course diminishes with the consumption of fuel.

Moreover, the above formula shows that, under the same conditions, the range will also be directly proportional to the ratio of the propeller efficiency, to the specific fuel consumption, and to the weights ratio $W/W-W_f$, which takes into consideration the total fuel load W_f required for the trip, as well as the structural qualities of the plane.

From this can be judged the importance, especially in the design of long range aircraft, of choosing each of the component parts with the utmost care and of assuring a careful adaptation of the over-all powerplant efficiency to aerodynamic characteristics best suited to severe conditions of flight.

The above formula, applicable only when flying is in calm air, should now be extended to meet the case of flight in headwinds, which is naturally the most difficult aspect of the problem.

If t designates the time required to fly a distance D in calm air at an average speed V_e and with a fuel load W_f then the distance R_1 which the same airplane will be able to cover with the same quantity of fuel, but with a wind component v, will be equal to

$$R_1 = R \pm v\,t = (V_e \pm v)\,t$$

the positive and negative signs referring to a tail or headwind, respectively. Thus, since

$$R = V_e\,t, \text{ then } \frac{R_1}{V_e \pm v} = \frac{R}{V_e}$$

In other words, assuming that the plane maintains the same average speed V_e in each case, the range R that the ship should have in calm air in order to be able to cover a distance R_1 against a headwind of intensity v equals

$$R_1 \cdot \frac{V_e}{V_e - v}$$

The assumption that the average air speed V_e remains the same in calm air or wind is really conservative since, as we know, it is advantageous rather to increase or decrease, respectively, the airspeed by an amount which can be mathematically determined for flight with headwind or tailwind.

The first equation can now be written in its final form as follows:

$$(1)\ R_1 \cdot \frac{V_e}{V_e - v} = 862.5 \cdot \frac{L}{D} \cdot \frac{\eta}{c} \cdot \log_{10}\left(\frac{W}{W - W_p}\right)$$

II. As a second equation in the group we shall consider the fundamental relation of lift to gross weight as applied to the case of the maximum value allowable for landing speed.

Because of the appreciable decrease in gross weight resulting from the large quantity of fuel consumed on a normal long range flight, it is advantageous, and has become of general practice

when dealing with this type of plane, to base the landing speed on a gross weight figure inferior to the take off weight by a certain fraction 1/F of the maximum fuel load. One-third to one-half has been chosen, depending on the other services the same plane would have to perform on short route. This arrangement, of course, necessitates fitting the plane with the proper equipment for rapidly dumping the specified amount of fuel in the event of a forced landing soon after takeoff at full gross weight.

Using the preceding notations, the second equation may then be written

$$0.00256 \cdot \frac{\rho}{\rho_0} \cdot C_{L_{max}} \cdot S \cdot V_L^2 = W - \frac{W\rho}{F} \quad (2)$$

in which, since landing speed is generally determined for sea level, we shall make $\rho/\rho_0 = 1$.

III. The third equation is based on the same fundamental formula as that above, but it is applied this time to the mean gross weight and the average airspeed V_c of the plane during a long range flight.

If we consider the mean gross weight as the maximum takeoff weight reduced by half the full load of fuel, then, with the same notation, this equation may be written:

$$0.00256 \cdot \frac{\rho}{\rho_0} \cdot C_{Lc} \cdot S \cdot V_c^2 = W - \frac{W_f\rho}{2} \quad (3)$$

(C_{Lc} refers merely to the cruising lift coefficient corresponding in this case to the angle of attack of maximum L/D.)

The choice of $W - W_f/2$ as mean gross weight may seem somewhat arbitrary since, according to the considered long range cruising technique, fuel consumption is normally greater in the first half of the trip than in the second, but the fact that the plane should arrive at destination with a certain reserve of fuel tends, in actual practice, to render the assumption sufficiently accurate.

IV. The fourth equation refers to the required maximum power. For certain flying boats, water characteristics may condition the takeoff so that more power is required at hump speed than purely aerodynamic characteristics demand at any other time. But for most land planes, and even modern flying boats, especially since supercharged engines have been allowed to furnish 110 percent or more of their rated horsepower at takeoff, it would seem that the climbing performance at full gross weight with one engine inoperative and only a normal amount of the rated power provided by the others, should be the criterion for total rated power needed.

In order to solve the problem for land planes as well as flying boats we shall define maximum power, then, on the basis of this type of abnormal climbing condition. For flying boats, the designer shall simply make sure that the corresponding take off power will be amply sufficient to take care of the critical hump speed condition and retain whichever value is the highest.

Let us now assume that a minimum rate of climb α is required at full gross weight, with only a ratio p percent of the total rated power (BHP) available. The well-known equation of rate of climb may then be written as follows:

$$\alpha = \frac{33000}{W}\left(\frac{\rho}{100} \cdot \eta \cdot \text{BHP} - \frac{\rho}{\rho_0} \cdot \frac{0.00256}{375} \cdot C_{Dc1} \cdot S \cdot V_{c1}^3\right)$$

In the parenthesis, the first term refers to the available power and the second (where V_{c1} and C_{Dc1} are the speed and the drag during climb) refers to the required power.

Now, if we remember that the best rate of climb is reached when the airplane is maintained at the incidence of maximum L/D, then we see that C_{Dc1} will be equal to the cruising drag coefficient C_{Dc}, and V_{c1} equal to the value of V_c, calculated by equation (3) for the gross weight W, (instead of $W - \frac{W_f}{2}$

The above equation then becomes:

$$\alpha = \frac{33000}{W}\left(\frac{\rho}{100}\eta \cdot \text{BHP} - 0.068 \cdot \frac{\rho}{\rho_0} \cdot C_{Dc} \cdot S \cdot V_{c1}^3\right) \quad (4)$$

Before taking up the equation for structural weight, which will complete the group, we will see how a fundamental relation, peculiar to flying at maximum L/D, simplifies and thus per-

TABLE I — Typical Computation Table
(Pertaining to Diagrams Such as Figs. 1, 2, 3, and 4)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
			For $C_{pe} = p_1$			For $C_{pe} = p_2$			For $C_{pe} = p_3$			For $C_{pe} = p_4$		
W_f	S	W/S	V_e	R_e	BHP	V_e	R_e	BHP	V_e	R_e	BHP	V_e	R_e	BHP
W_1	S_1	W_1/S_1	V_1'	R_1'	HP_1'	V_1''	R_1''	HP_1''	V_1'''	R_1'''	HP_1'''	V_1''''	R_1''''	HP_1''''
W_2	S_2	W_2/S_2	V_2'	R_2'	HP_2'	V_2''	R_2''	HP_2''	V_2'''	R_2'''	HP_2'''	V_2''''	R_2''''	HP_2''''
W_3	S_3	W_3/S_3	V_3'	R_3'	HP_3'	V_3''	R_3''	HP_3''	V_3'''	R_3'''	HP_3'''	V_3''''	R_3''''	HP_3''''
W_4	S_4	W_4/S_4	V_4'	R_4'	HP_4'	V_4''	R_4''	HP_4''	V_4'''	R_4'''	HP_4'''	V_4''''	R_4''''	HP_4''''

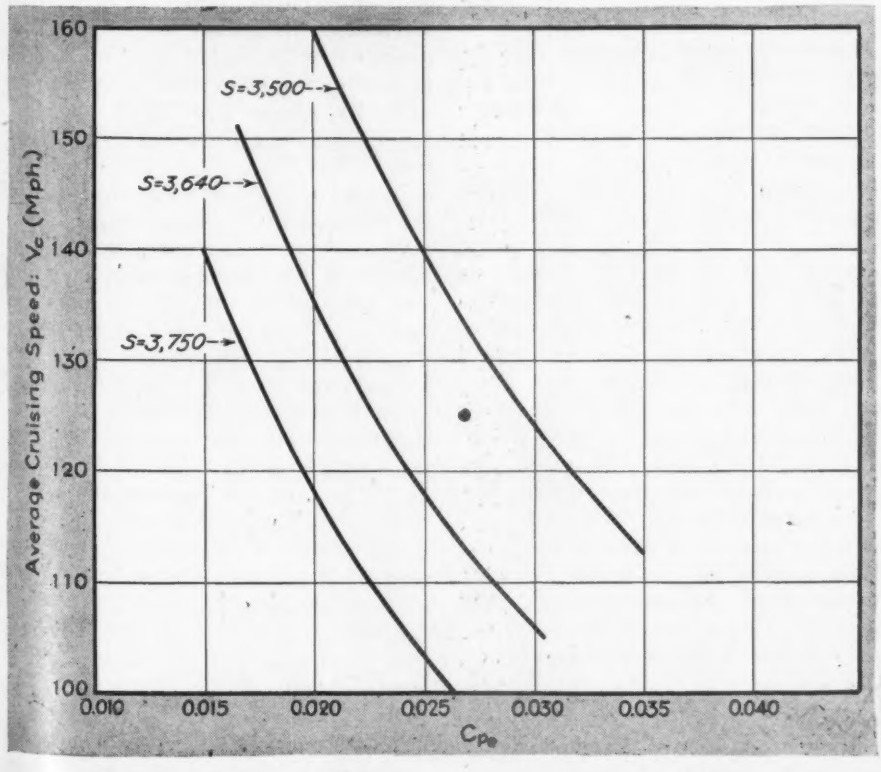


Fig. 2. Average cruising speed V_c (true airspeed at sea level) **vs. minimum parasite drag coefficient C_{p_e} for different wing areas S.**

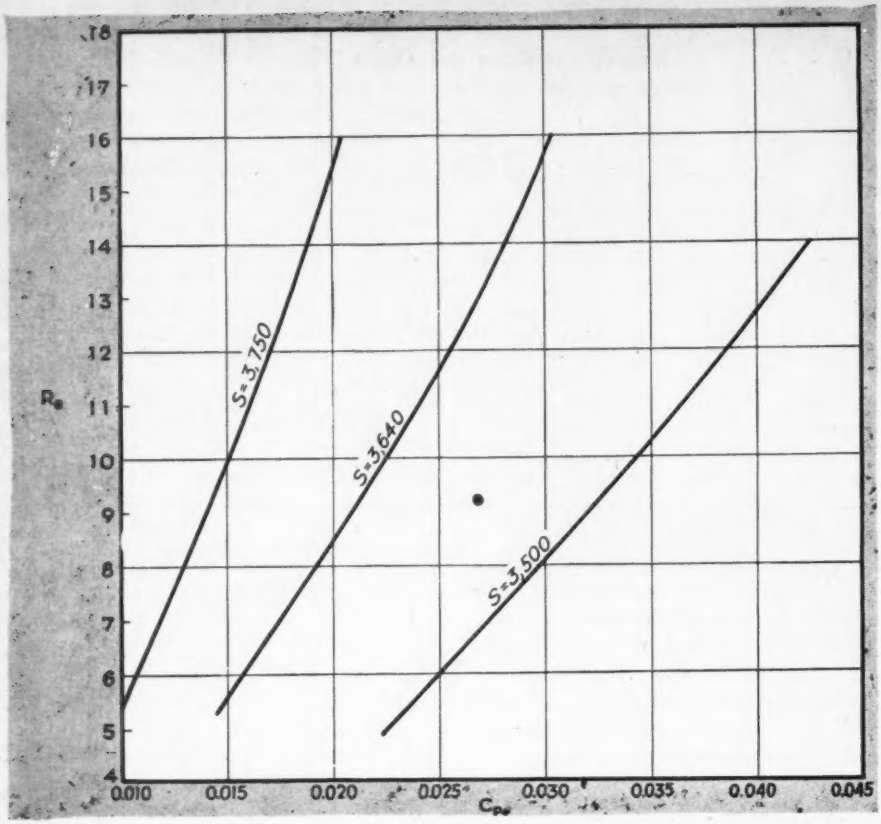


Fig. 3. Required virtual aspect ratio R_e vs. minimum parasite drag coefficient C_{pe} for different wing areas S.

mits solving the system of the four preceding equations.

If we call C_{Lc} and C_{Dc} the lift and drag coefficient, respectively, the notation c referring to "cruising value," it is known that for the polar point of maximum L/D they can be expressed in terms of the coefficient of minimum parasite drag C_{pe} and effective aspect ratio of the total airplane R_e, by the following formula:

$$C_{Lc} = \sqrt{\pi R_e C_{pe}}$$
$$C_{Dc} = 2 C_{pe}$$

Using these relations, the system of four equations may now be written under the following, final forms:

$$(1)\quad R_1 \times \frac{V_c}{V_c - v} = 863.5 \cdot \sqrt{\frac{\pi R_e}{4 C_{pe}}} \cdot \frac{\eta}{c} \cdot \log_{10} \frac{W}{W - W_f}$$

$$(2)\quad S = 390 \cdot \frac{W - \frac{W_f}{F}}{C_{Lmax} \cdot V_L^2}$$

$$(3)\quad V_c^2 = 390 \cdot \frac{\rho_0}{\rho} \cdot \frac{W - \frac{W_f}{2}}{S \cdot \sqrt{\pi \cdot R_e \cdot C_{pe}}}$$

$$(4)\quad \alpha = \frac{3.3}{W}\left(1.00 \cdot p \cdot \eta \cdot \mathrm{BHP} - 136 \cdot \frac{\rho}{\rho_0} \cdot C_{pe} \cdot S \cdot V_c^3\right)$$

General Method of Solution

It is well to recall at the outset which factors are known and which unknown, the latter being those for which the system must be solved. The known factors can be divided into two categories, those given by operation requirements and those furnished by experimental data. We shall list them in turn as follows:

(A) Known factors given by operation requirements:

Plane's size and full gross weight W (from the general operation requirements and the necessary accommodations of the fuselage or hull).

Range R_1

Maximum value of average headwind component to be considered v.

Upper limit imposed to the landing speed V_L.

Fraction 1/f of the fuel load which can be considered as normally burned up, or exceptionally dumped, before landing at that specified speed.

Minimum value assigned to the rate of climb α, when only p percent of the total rated power is available just after takeoff at full gross weight, one engine being completely inoperative.

Normal zone of altitudes at which the plane usually will be operated. (B) Factors given by experimental data (depending upon the technical standards of the moment) for plane and power plant:

Average propeller efficiency η.

Minimum value which can be assigned for average specific fuel consumption c.

Normal value to be assigned for maximum lift coefficient C_{Lmax}. (depending upon the type of airfoil and high lift device chosen).

There remain to be found the optimum values to consider for the following unknown fundamental characteristics of the design:

Wing area S, which shall give the wing loading: $\frac{W}{S}$

Total rated BHP which gives power loading W/BHP and, indirectly, the preferable number of engines.

Average cruising speed V_c and the necessary fuel load W_f corresponding to the values found for the above factors.

It should be remembered that the problem will be solved with the idea in mind of finding the lowest possible value for the total $W_s + W_f$ of the structural and fuel weights.

The following procedure summarizes the successive steps to follow in obtaining the solution:

1. Assign a certain number of arbitrary values to W_f, such as W_1, W_2, W_3, W_4, chosen of course within reasonable limits. Substituting these in equation (2) we find the corresponding values for the wing area S.

2. In the same way assign reasonable, arbitrary numerical values to C_{pe}, such as p_1, p_2, p_3, p_4. Substituting these together with the different combinations of values already found for W_f and S, we can solve equations (1) and (3) for the corresponding values of aspect ratio R_e and average cruising speed V_c.

3. These first results can then be summed up in a table (such as our accompanying Table I). They also make it possible for us to draw such families of curves, as shown in Figs. 1, 2, and 3, for the numerical example which follows.

4. Equation (4) enables us then to find the corresponding values for the necessary total rated power as listed in columns 6, 9, 12, and 15 of the same table and from which will also be drawn a family of curves such as shown in Fig. 4.

The next step consists in finding, among the infinite number of combinations offered by these four diagrams, a locus of the possible solutions afforded by the technique of the moment.

Since C_{pe} has been chosen as the common variable, it would seem logical to represent this locus in terms of that same parameter. This can be done by considering that the minimum parasite drag coefficient will, for a given wing area and hull or fuselage size, be essentially a function of the power arrangement. Thus, if an estimate of this coefficient is worked out for different combinations of power and considered

wing areas, we shall be able to represent its variations by dotted lines, such as those drawn on Fig. 4.

It is then easy to see that the intersection of these lines with the curves of the corresponding wing area represent the lowest values which might actually be obtained for the minimum parasite drag pertaining to each considered value of wing area.

These values thus constitute a few points of the desired locus which can then be represented by a curve, such as drawn on Fig. 5.

The remainder of our problem can now be solved by finding the values of the corresponding weight quantities $W_s + W_f$, and expressing their variation by a curve, such as that shown on Fig. 6, for the numerical example. Its minimum will obviously determine the optimum value to retain for the wing area. In actual practice, however, the choice would have to be made of the value, most closely approaching that minimum, for which a possible engine arrangement already exists.

Once the wing area has been decided upon, all the other main design characteristics can be directly deducted from the preceeding diagrams.

In comparing the weights as well as the difference in payload pertaining to the possible solution, it should be noted that the hull or fuselage size may be treated as a constant, since, with its accommodations, it does not vary like the other variables of the project.

In estimating the weight values W_s, we will concern ourselves only with those parts of the airplane other than the hull or fuselage.

Every aircraft manufacturer has for this an empirical formula of his own, using the coefficients best adapted to his type of construction. In order to have this study complete, however, we shall include here an example of such a formula.

If we consider the standard structure of a modern, all metal, cantilever wing, we see that its weight can be divided into two components: One, the weight of the external covering, proportional, therefore, to the wing area; the other, the weight of the stressed inner structure, conditioned mostly by the flexion loads and depending, therefore, upon the load factor, the wing loading, and aspect ratio.

Laws of geometric similarity, together with the theories of simple stress analysis, show that, with a fair approximation, the stressed structure weight can be expressed in the following form:

$$k_1 \cdot \frac{W}{S} \cdot S^{3/2} \cdot \lambda^{3/2} = k_2 \cdot W \cdot S^{1/2} \cdot \lambda^{3/2}$$

k_2 being a coefficient of proportionality depending mainly upon the load factor.

(*Turn to page* 296)

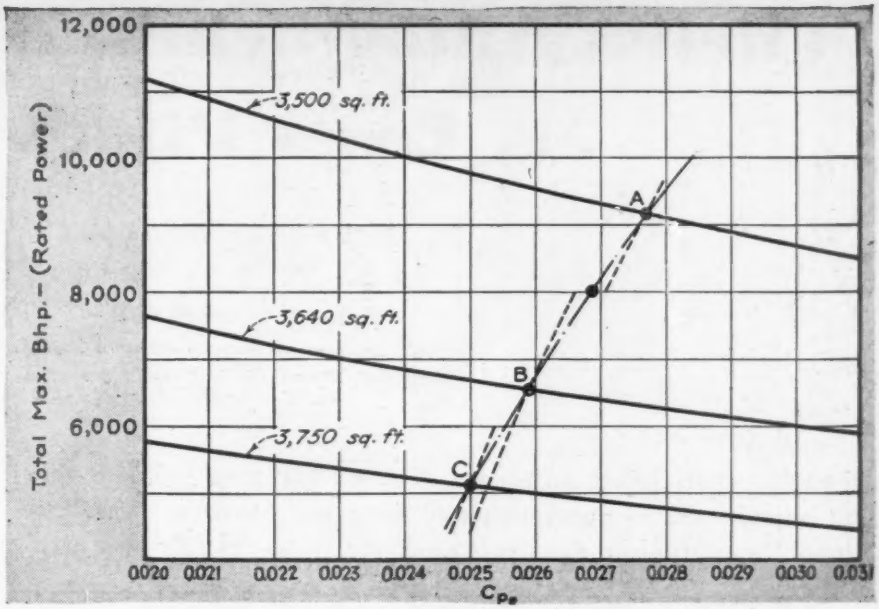


Fig. 4. *Continuous line:* Total required bhp. (rated) vs. minimum parasite drag coefficient C_{p_o} for different wing areas S. *Broken line:* Variation of minimum parasite drag coefficient C_{p_o}, estimated for different power combinations at constant wing area. *Dash-and-dot line:* Locus of possible solutions expressed in terms of C_{p_o} vs. total required power.

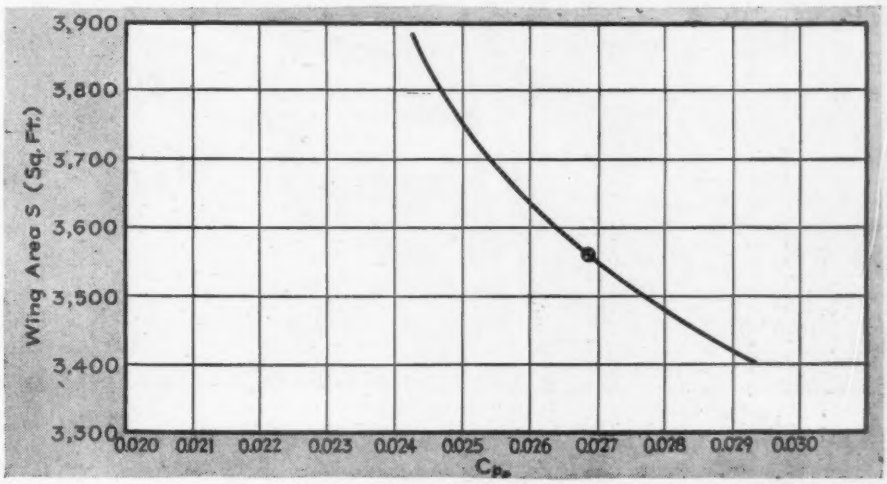


Fig. 5. Locus of possible solutions expressed in terms of C_{p_o} vs. wing areas S.

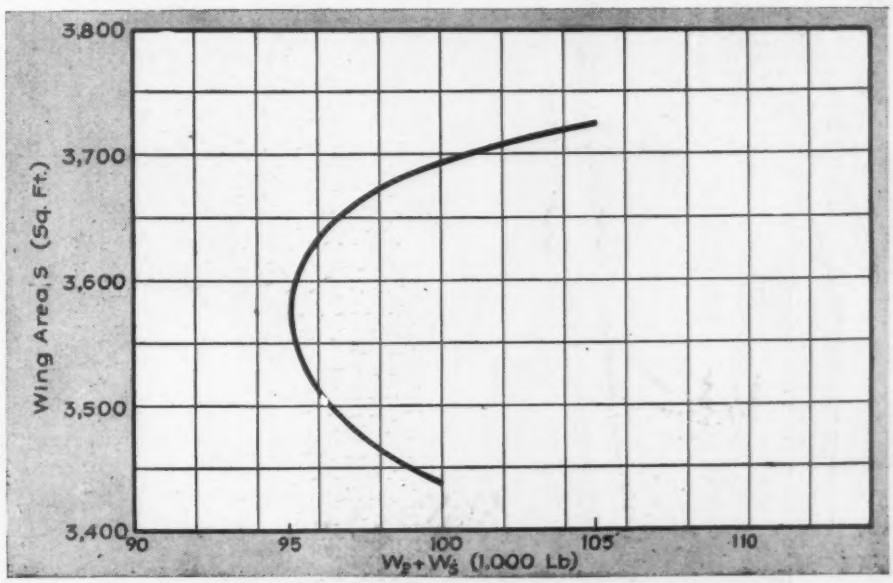


Fig. 6. Variation of weight quantity $W_s + W_f$ vs. wing area S, along the locus of possible solutions.

Curtiss Autosynchronizes Engines . . . Eases Pilot's Job

By GEORGE W. BRADY
Chief Engineer, and

MARVIN MEYER
Project Engineer in Charge of Propeller Controls, Propeller Division, Curtiss-Wright Corporation

Multi-engine craft pilots no longer need bother with periodic time-taking adjustments of constant-speed propeller controls. The "proportional" synchronizer does the work for them. Here's how . . .

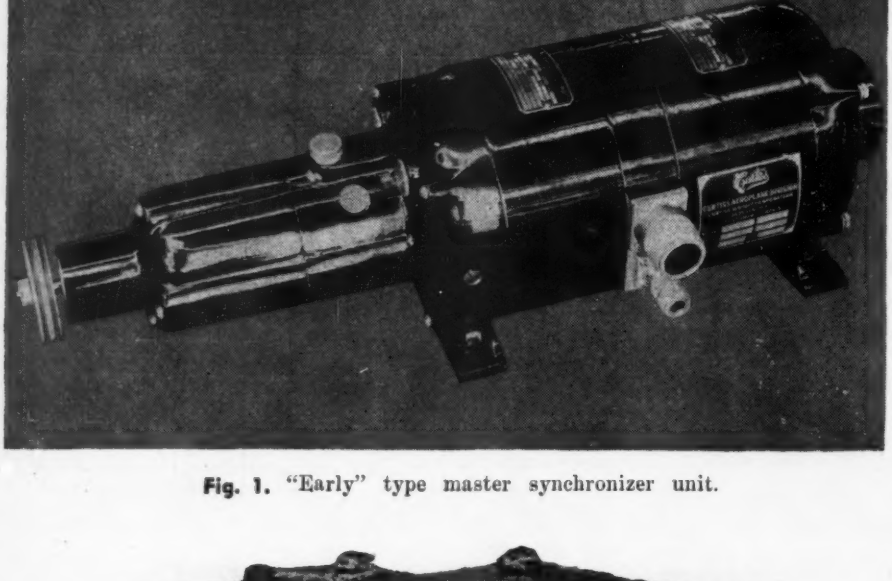


Fig. 1. "Early" type master synchronizer unit.

Fig. 2. "Early" contactor unit.

NEED FOR automatic synchronization of engines on multi-engine aircraft—to relieve the pilot or flight engineer of periodic adjustments of constant-speed propeller controls—has long been recognized. And now, in the development of the Curtiss Automatic Engine Speed Synchronizer, such synchronization has become a reality.

Already in operation on the Navy Consolidated PB2Y series of patrol planes, this type of control equipment, used with Curtiss electric propellers, both automatically synchronizes the speeds of all engines and maintains any selected constant speed.

The synchronizer, now in volume production, stems from a program initiated several years ago by the Curtiss-Wright Propeller Division in New Jersey. Initial step was the design, construction, and testing, under sponsorship of the Army Air Corps, of the four-engine synchronizer system now referred to as the "Early" type. This has now been superseded by the improved "Proportional" type.

After extensive laboratory and test-stand work, the first "Early" type unit was installed and flown on a Navy Sikorsky XPBS-1 four-engine patrol plane in January, 1939. This equipment was designed to control the four Curtiss electric propellers—the same kind as used with standard governor control—in such a manner as to obtain both constant speed and automatic synchronization by the same control system. In addition, the device consisted of a single master synchronizer unit, contactor unit, and relay for each engine, principal units of which are shown herewith in Figs. 1 and 2.

The master unit, which was installed near the cockpit and connected to an rpm. control on the pilot's control panel, consisted of an adjustable constant-speed motor that operated a three-phase permanent magnet alternator. The contactor units mounted on the engine governor pad were small three-phase induction motors that had the rotor driven by the governor drive. The stator windings were connected to the alternator of the master unit.

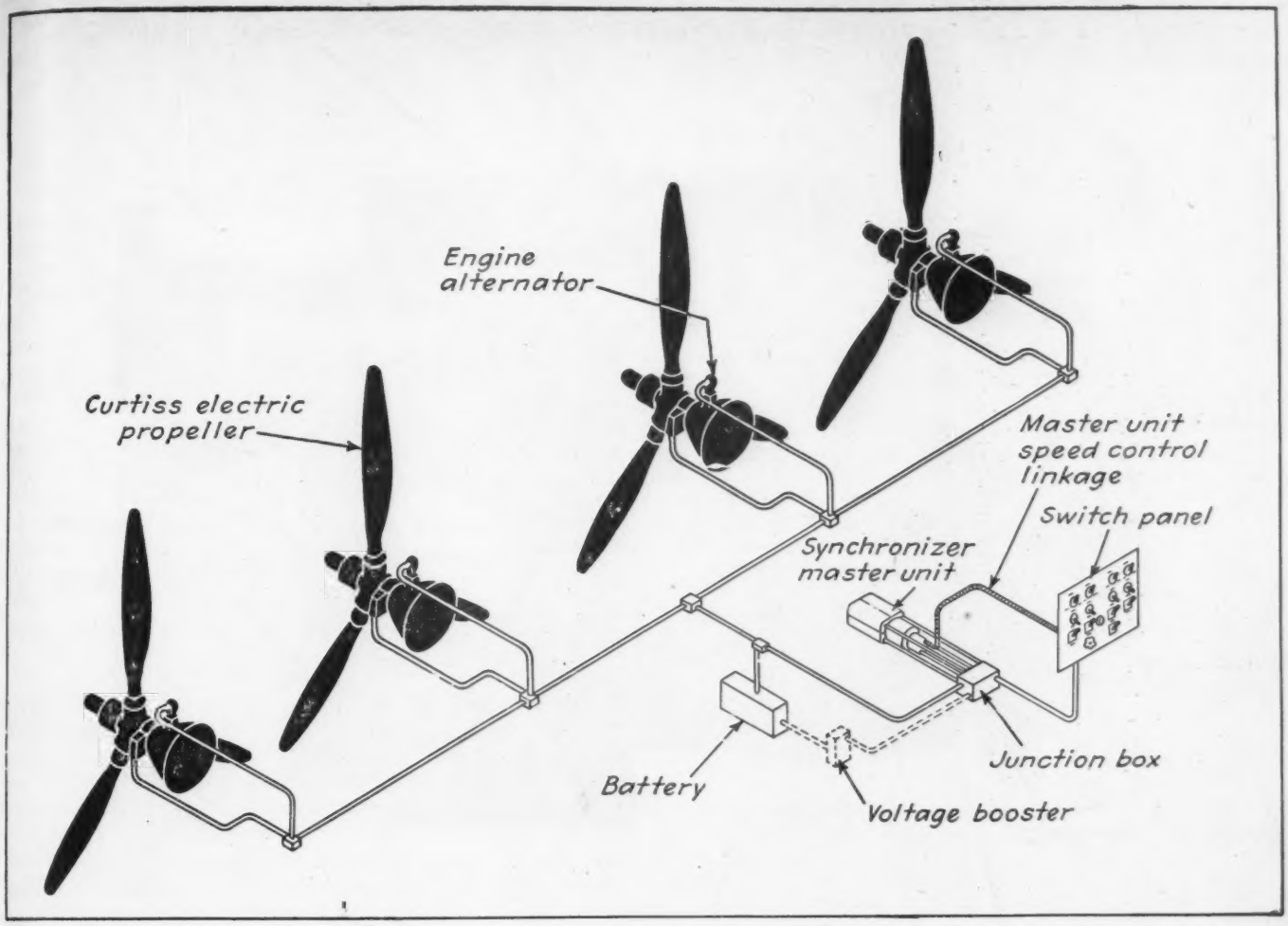


Fig. 3. Typical installation of new "Proportional" type synchronizer (now in production) on a four-engine airplane.

The stator was mounted on bearings, to be able to swivel through a small arc against a spring, the direction of motion depending on whether the rotor speed was above or below the frequency of the alternating current from the master unit. Contact points were installed in the head of the contactor so that the increase or decrease rpm. circuits to the relay would be closed as the stator pivoted in response to speed changes.

In turn, the relay controlled the pitch of the propeller so as to make corrections that would synchronize the engines to the speed of the master unit. By having all propellers controlled by the same master unit, synchronization of all engines was automatically obtained.

Flight tests proved that the system of synchronizing all engines to a single constant-speed source was both sound and generally satisfactory. However, together with previous test-stand experience, certain refinements were necessary to obtain consistently the extremely close control desired. To incorporate these features, a major redesign was undertaken as the second step in the synchronizer development program. Sought were:

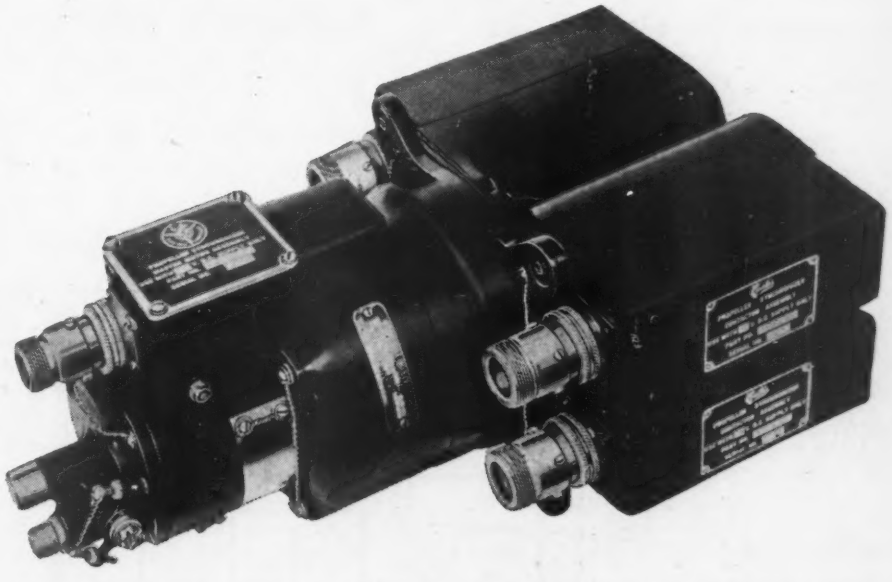


Fig. 4. Master unit (master motor and contactors) employed in Proportional system.

1. Retention of the constant-speed control circuit of the master motor but with an improvement in order to maintain precise constant speed under the load and voltage variations present in the average airplane installation.
2. Incorporation of the sensitive control elements of the engine-mounted contactor unit in the master unit so as to remove these elements from the severe vibration of the engines.
3. Development in the contactor units of truly synchronous characteristics replacing those formerly only approximate.
4. Achievement of truly synchronous operation without hunting or surg-

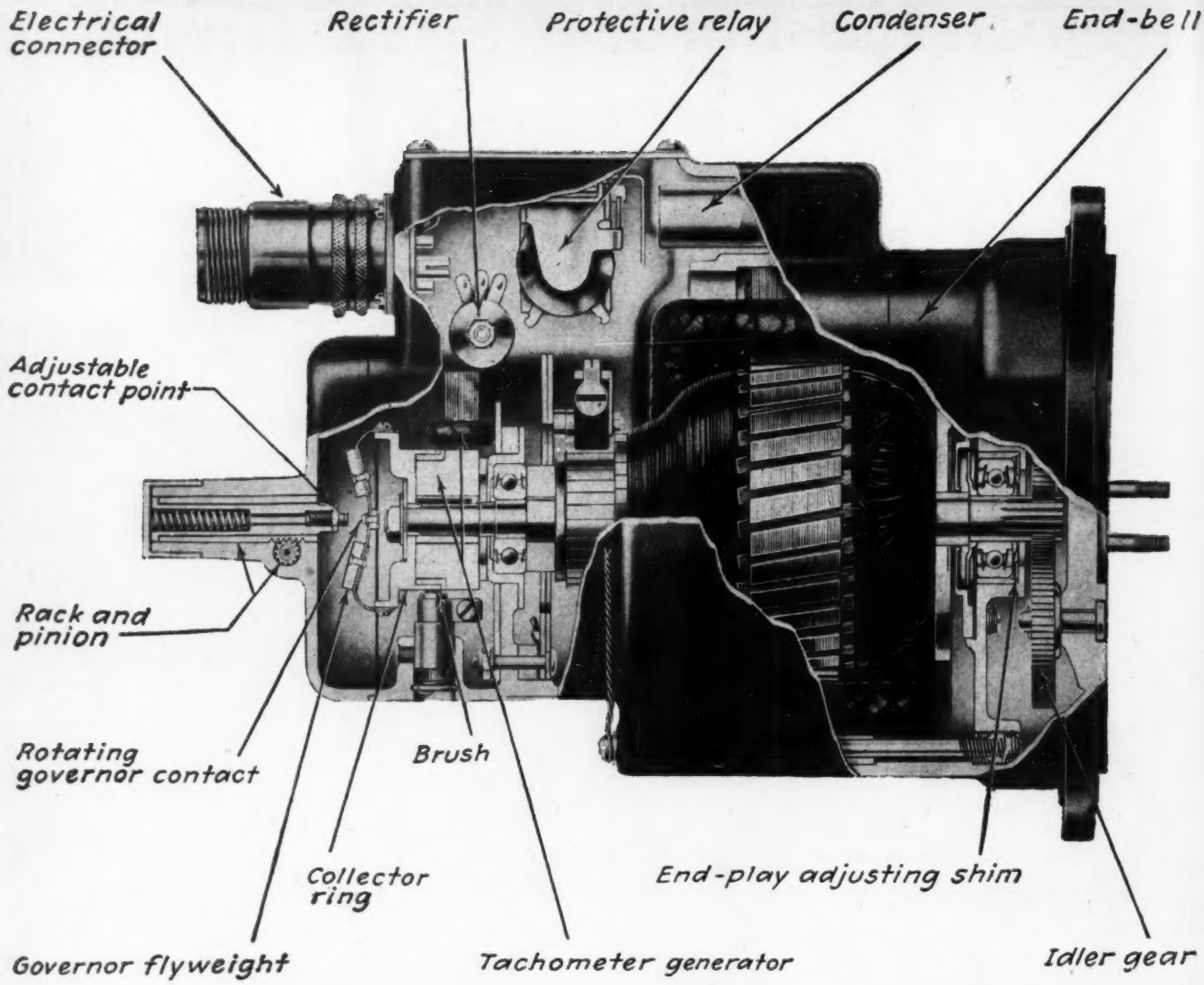
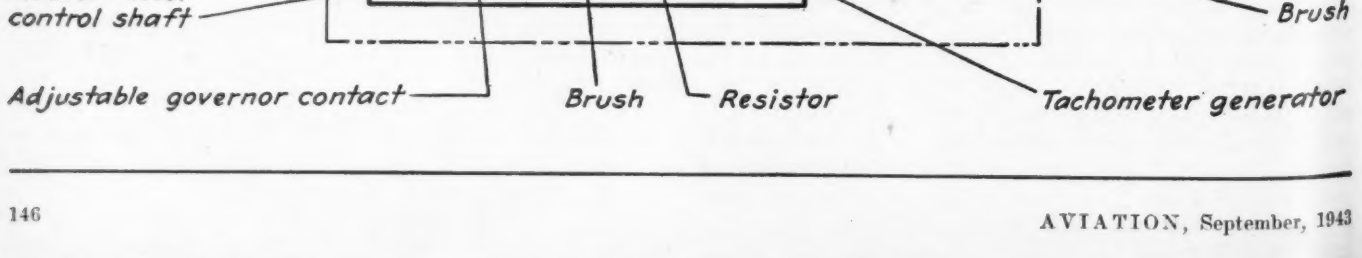


Fig. 5. (above) Cutaway sketch of master motor assembly . . . **Fig. 6.** (below) Schematic diagram of its wiring.



ing, the control to be proportional to off-speed within a certain range of rpm. above and below the desired speed setting.

5. Reduction in weight to make the synchronizer system at least equivalent to the weight of the conventional constant-speed governor system including the governor controls in the calculation.

The system of control called the "Proportional Synchronizer," developed to meet all these requirements, was laboratory-tested in 1939 and 1940 with very satisfactory results. This equipment was first flown in Sept. 1940, on an Army Boeing B-17B bomber and on the Navy Consolidated XPB2Y-2 in December, 1940

Success of these installations resulted in adoption of this new system on production Consolidated PB2Y-3 planes and on the Boeing XPBB-1 patrol bomber. Other installations are being made on several new models of airplanes of both fighter and bomber classes. Service experience obtained makes it appear probable that eventually there will be general adoption of automatic synchronizer control systems on all four-engine and many two-engine planes.

It has been learned from experience that the installation of the new proportional synchronizer is appreciably simpler than that of the standard constant-speed governor system. This is so because the mechanical connections generally required with individual constant-speed governors have been eliminated. Weight of the synchronizer installation has been found to be comparable to the standard governor installation. Fig. 3 illustrates the installation of the proportional synchronizer on a four-engine airplane.

The master synchronizer unit shown in Fig. 4 is comprised of the master motor *a* coupled with contactor units *b*. One of the latter is provided for each engine. Engine speed is introduced into the contactor units through wiring from three-phase alternators, one of which is mounted on each engine, usually on the governor drive pad. The pilot, and in some installations also the flight engineer, is provided with conventional propeller switches, in addition to a master unit switch, master unit control knob, and a tachometer to indicate the speed at which the master unit is operating.

The master motor, a sectional view of which is shown in Fig. 5, is a manually adjustable constant-speed, governor-controlled, d.c. motor which operates directly from the airplane's voltage supply. Developed by General Electric, this motor is different from the conventional governor-controlled d.c. motor in that the governor contacts act on a very sensitive control field requiring only a very small amount of current.

Fig. 7. Tachometer used to indicate master motor speed. It is installed either in cockpit or on flight engineer's panel.

Governor contacts are placed across one of two opposed sections of the control field, with the result that when the contacts are open the control field is very weak and the motor tends to speed up. Conversely, when the contacts close, the control field becomes relatively strong and the motor slows down.

This action takes place at a high frequency when the motor is regulating at constant speed. It cannot be detected in the output shaft by normal methods, due to the extremely small speed differential required to cause the opening and closing action. The rpm. at which the master motor regulates is changed by shifting the position of one of the regulating contacts by means of either a lever or flexible shaft type control. Maximum and minimum stop settings are provided on the master motor for setting the desired takeoff and minimum operating speeds.

Contact action of the master motor governor produces a pulsating voltage, across each section of the control fields, which is used for operation of a protective relay circuit, as shown in the master motor wiring diagram, Fig. 6. This operates in such a way that in event the master motor fails to operate at the regulated speed because of failure of the power supply to the master motor, inadvertent operation of the master switch, or other causes, the relay will open and the propellers will remain in fixed pitch at whatever position they were operating at the time of failure.

A green tel-light is usually provided, operated by the contacts on the protective relay, to indicate when the master motor is operating satisfactorily. On some installations it has been found desirable to operate this tel-light through the automatic position of the propeller selector switch, in which case one tel-light is provided for each propeller to indicate not only that the master motor is operating satisfactorily but also to show that the propeller selector switches have been placed in the automatic position.

The master motor also incorporates a small permanent magnet-type alternator to operate the tachometer (illustrated in Fig. 7) which is installed either in the cockpit or on the flight engineer's panel to indicate the master motor speed.

This tachometer comprises a simple

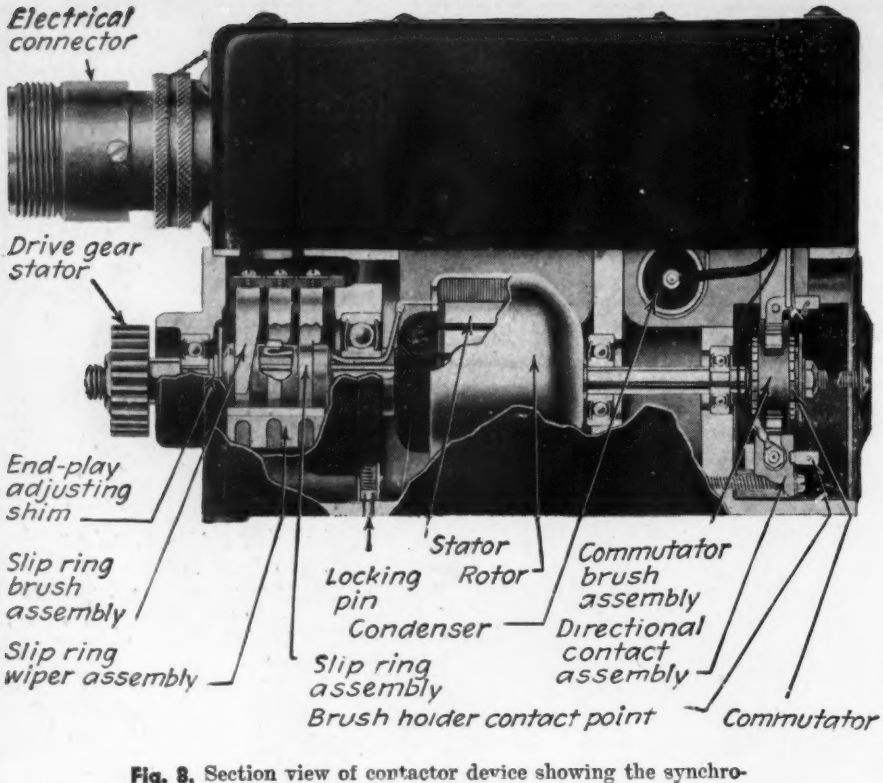
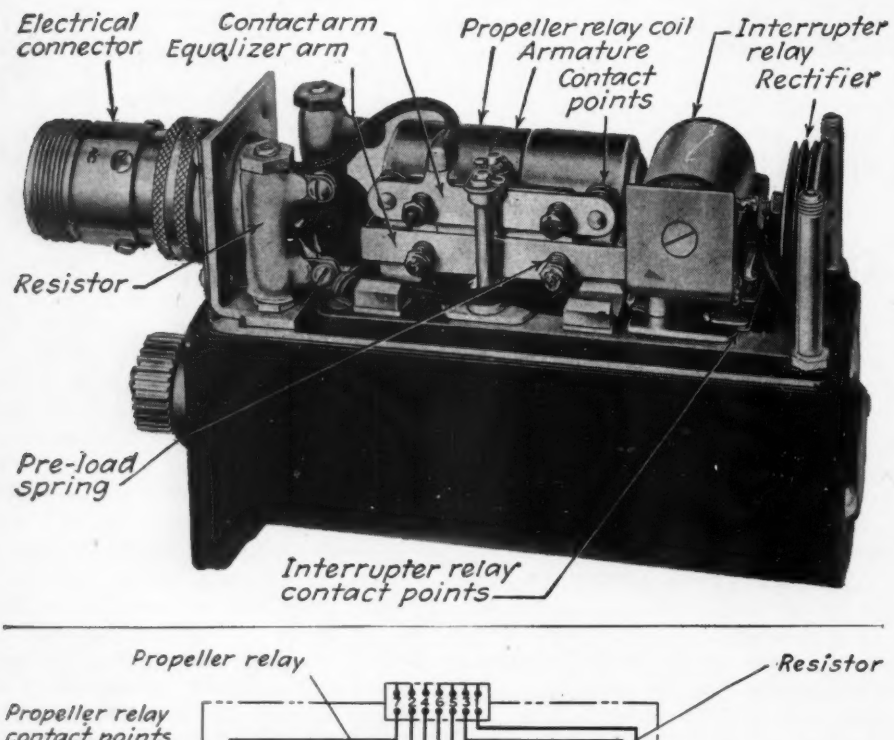


Fig. 8. Section view of contactor device showing the synchronous motor and (below) contactor assembly with relay panels.



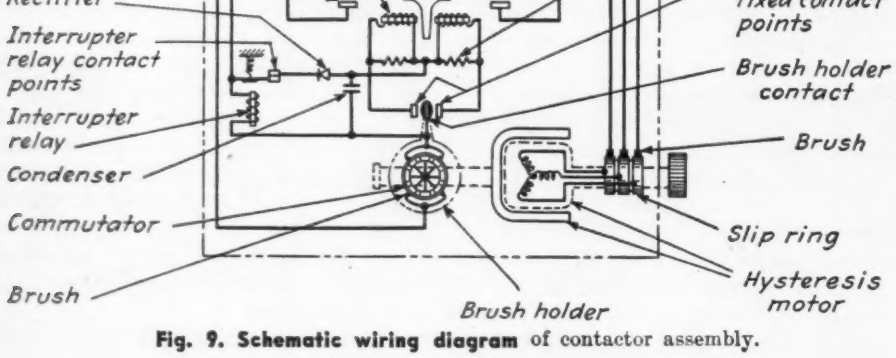


Fig. 9. Schematic wiring diagram of contactor assembly.

d.c. voltmeter type instrument, employing a 270-deg. pointer movement for convenience in reading. The unit is operated from a bridge-type rectifier circuit and a saturated core transformer that is excited from the master motor tachometer alternator.

Variations in voltage output in the permanent magnet alternator do not affect the tachometer calibration because of the action obtained from the saturated core transformer, permitting use of any tachometer with any master motor and allowing employment of either one or two tachometers, as desired on the installation.

The tachometer is calibrated to read directly in engine rpm. after reckoning the drive ratio between the governor pad, (on which the engine alternator is mounted) and the engine crankshaft. For convenience in indicating takeoff rpm., the tachometer dial is provided with a red marker which may be set to the specified value.

The contactor units, illustrated in section by Fig. 8, serve to compare the speed of the engine, which each particular unit controls, with that of the master motor. They also provide the necessary current impulses to the propeller, in the proper direction so as to cause the propeller to either increase or decrease pitch by the amount that is required to restore synchronous engine speed.

Each contactor consists of a small synchronous motor, a contact mechanism, and two relays. The synchronous motor is electrically driven by the alternator on the engine and has both its stator and rotor mounted on ball bearings.

The stator is mechanically rotated by the master motor, in the opposite direction to the rotating magnetic field produced in the stator by the alternator. The resultant rotation of the rotor is therefore proportional to the difference in speed between the geared-down speed of the master motor (contactor speed) and the speed of the engine. When the rotor speed is zero, with both the master motor and the engine running, the two are said to be in synchronism.

The rotor of the synchronous motor is used to drive a contact mechanism made up of a commutator, a brush-holder, and direction-sensitive contact. The brush holder is restrained from rotating by the direction contacts. The interrupter relay is energized directly through the brush holder, and the commutator contact mechanism serves to interrupt the circuit to the propeller relay coils preventing further pitch change correction should the rotor, because of being in exact synchronism, stop when a contact is being made.

The propeller relay is also energized by the brush and commutator mecha-

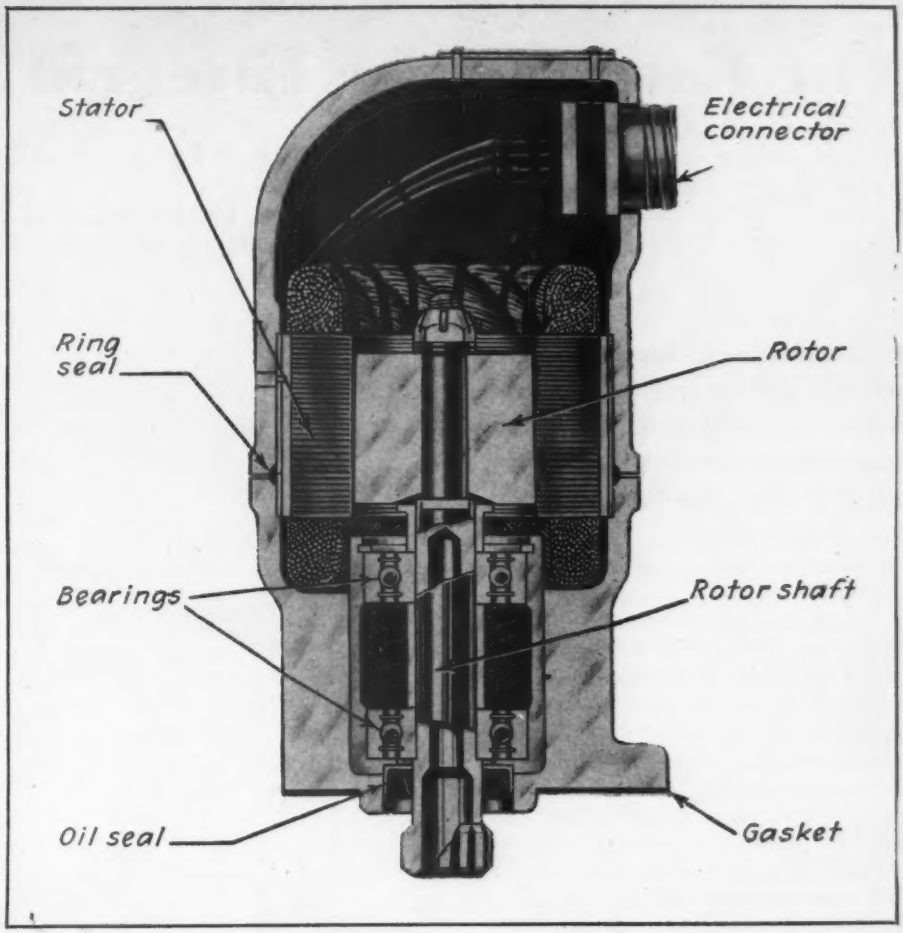


Fig. 10. Exterior (above) and cross section views (right) of engine alternator.

nism through the direction contacts. General arrangement of this circuit is shown in Fig. 9. Time-delay characteristics of both the propeller relay and the interrupter relay are so adjusted —by means of paralleling resistors and condensers.

As the amount of off-speed increases, frequency of contact also increases until finally the time interval between impulses to the propeller is reduced to zero and solid correction takes place. With eight contacts per revolution of the contact mechanism, solid correction is obtained at approximately 60 rpm. and 65 rpm. off-speed for the respective decrease and increase rpm. corrections.

To prevent the time-delay action of the main propeller relay from affecting the operation of the interrupter relay, it is necessary to separate the two circuits. This was most conveniently done with a rectifier (Fig. 9).

As already pointed out, if for any reason the master motor is not operating at the speed for which it has been set, the propellers will remain in fixed pitch, unless operated manually by the cockpit switches. This is accomplished by grounding the contactor relay circuits through the protective relay contacts. Thus no operation of the contactor relay is obtained unless proper master motor operation is also affected.

Remaining unit of the system is the engine alternator shown in Fig. 10. This unit, usually mounted on the engine governor pad, is a simple permanent magnet-type three-phase alternator. The mounting pad and splined drive are the same as normally used on the conventional governor. Output of the alternator, as previously mentioned, is used to drive the small synchronous motor which is an integral part of the contactor unit.

A typical arrangement of the propeller switches, tachometer, control knob, and tel-light for a four-engine installation including fast feathering is shown in Fig. 11. As an alternate to the knob and shaft method of controlling the setting of the master unit, provision is made for a push rod connection from a quadrant in the cockpit.

Operation of the propeller controls with the automatic synchronizer system is simple. The master unit switch must, of course, be "On" with the propeller selector switches placed in the "Automatic" position. Desired engine speed is obtained by adjusting the master motor control knob until this speed setting is indicated by the master motor tachometer. Operation of one or more propellers in fixed pitch, or feathered, does not interfere with the operation of other propellers set for automatic constant speed.

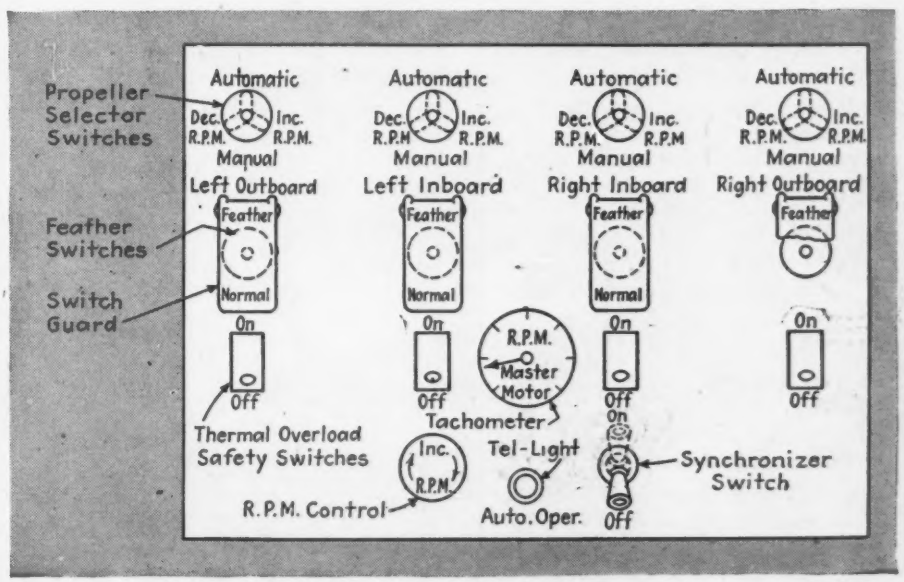


Fig. 11. Diagram of typical switch panel for a four-engine installation.

The Case for the Integral Power Plant

Part I

By SANFORD A. MOSS, Ph.D., LL.D.
Consulting Engineer, Supercharger Engineering Div., General Electric Co.

With a terse consensus of industry leaders and service men providing his critical medium, the author augments his earlier proposals for integral and standardized aviation power plants.

LET US ADVANCE two related propositions: First, that aviation power plants, especially when they include turbosuperchargers, be planned as integral units, completely self-contained; and second, that for each general type of airplane assembly, all power plant mounts and all plane structure supports for power plant mounts be standardized *only so far as connection to each other is concerned.*

Then for each type and/or horsepower of airplane assembly, different power plants will be interchangeable on a given plane, or a given plane can interchangeably use different power plants.

In accordance with the integral plan, an aviation power plant would be built

Pro, "Middle," and Con

opinions on this significant power plant question are offered in this timely two-part series. Included are the cogent views of—

A. KARTVELI, chief engineer, Republic Aviation Corp.

J. CARLTON WARD, JR., president, Fairchild Engine & Airplane Corp.

J. E. ELLOR, engineer, Rolls-Royce, Ltd.

LT. COMDR. SCRYMGEOUR.

ROBERT WINSLOW, Continental Aviation & Engineering Corp.

C. A. STAM, engineer, Chrysler Corp.

CHARLES W. MORRIS, AiResearch Mfg. Co.

KENDALL PERKINS, McDonnell Aircraft Corp.

LOUIS E. BARNES, Fisher Body Detroit Div., General Motors Corp.

COL. GEORGE C. CROM, AAF Materiel Command, Wright Field.

T. P. HALL, chief development engineer, Consolidated Vultee Aircraft Corp.

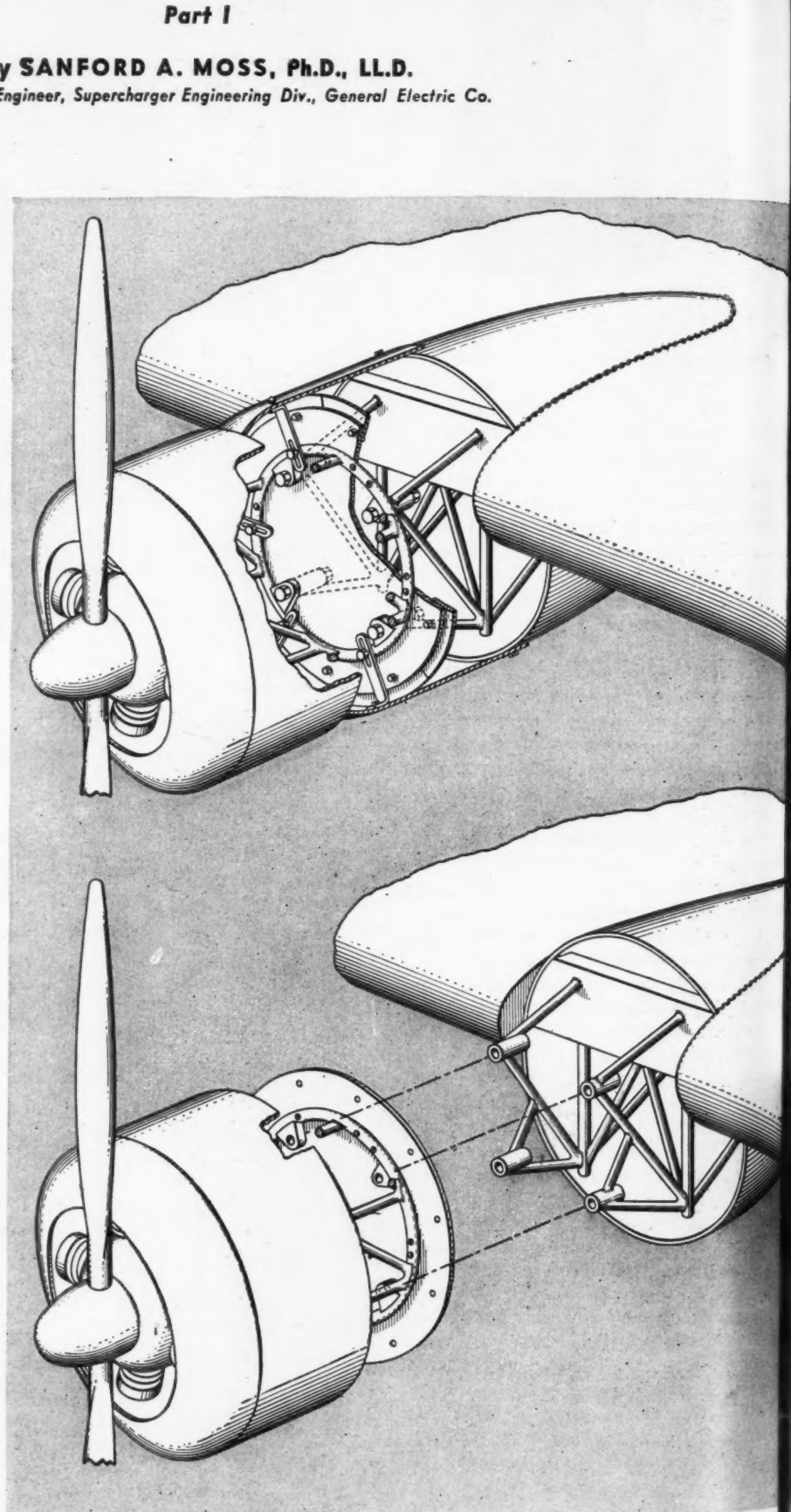


Fig. 1. Schematic diagram of standardized mount bosses for integral power plants. Items proposed for stardardization are location and design of mount bosses for both plane and power plant structures.

o form the front section of a nacelle —designed, assembled, and tested as a nit by groups specializing on this job. These power-plant specialists would rrange the assembly of engines, turbo-uperchargers, generators, propellers, nd all accessories, to get a certain over-ll performance.

Other groups of aerodynamic special-sts would, in parallel, prepare the lane up to, and including, the plane tructure support for the power-plant ount. They would provide the bosses erminating this plane structure sup-ort, to which the integral power plant ount afterward would be attached. A rewall might be a part of the power-lant section, with the various acces-ories bolted on both sides of it.

Standardized Power Plants

Integral power plants would readily end themselves to a standardized rrangement, so that any plane of a iven general type would take any ntegral power plant of a correspond-ng general type. One might even dare o hope for a British-American stand-rd—so that an American integral ower plant would fit a British plane, nd vice versa. Of course, there would ave to be standards for mount astenings, weights, center of ravity, thrust, gasoline, electric nd control connections, etc. (See Fig. 1.)

The propositions made herein ere discussed briefly during a ecent Detroit meeting of the ociety of Automotive Engin-ers but with only two and a alf columns of publication of lan and discussion[1]. We now ffer a full and improved pre-ntation of the plans together ith the pro and con views of a umber of eminent engineers, their opinions being added to those of the author in order to give a complete survey.

The situation with respect to single-engine planes is presented by A. Kartveli, chief engineer, Republic Aviation Corp.:

"It is believed that integral power plants are feasible in the case of fairly simple installations, such as those involving unsupercharged or single-stage supercharged engines. It is also possible that an integral power plant could be designed, for two-stage or turbo-supercharged engines, which would be satisfactory on large multi-engine airplanes. It is extremely doubtful, however, that an integral installation involving a large and complicated power plant could be made standard for all pursuit type airplanes without making serious sacrifices in the performance or other qualities of the airplanes."

Kartveli has written out in detail a number of difficulties with an integral power plant with such single-engine planes, and he concludes:

"Then there is the question of balance. The pilot should be located forward for good vision and the fuel must be near the C.G. With all this weight located forward, balance can only be attained by moving the wing so far forward on the airplane that the principle wing structure passes through the power plant installation.

"If any serious attempt is made to develop the integral power plant idea, it is believed advisable to start with the simplest power plants. If these prove to be of sufficient advantage to merit wide acceptance, the study could be extended to the more complicated types."

It is to be borne in mind that Kartveli is considering single-engine planes. But it may be hoped that ways will be found to solve his problems.

The general propositions presented here have for some time found actual employment in England. A report about this was made by J. Carlton Ward, Jr., president of the Fairchild Engine & Airplane Corp., who was a member of a recent commission to England. He wrote[2]:

"We saw aircooled engines going into fighters and liquid cooled engines into bombers. We saw airplanes that could take either liquid or aircooled engines. In other words, we saw the 'power egg' at work. By 'power egg' I mean a power installation wherein the engine manufacturer's task is not complete until the power plant is so placed in the airplane that it can give a maximum thrust horsepower".

J. E. Ellor, an English engineer of Rolls-Royce, Ltd., Derby, England, and who now is representing Rolls-Royce with the Packard organization in Detroit, has had actual experience in England with the items here discussed. Writes Ellor:

"A number of years ago, engine builders realized the many

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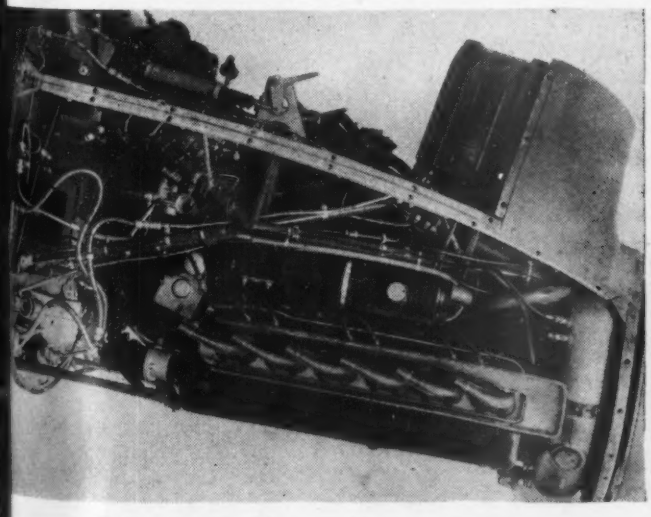


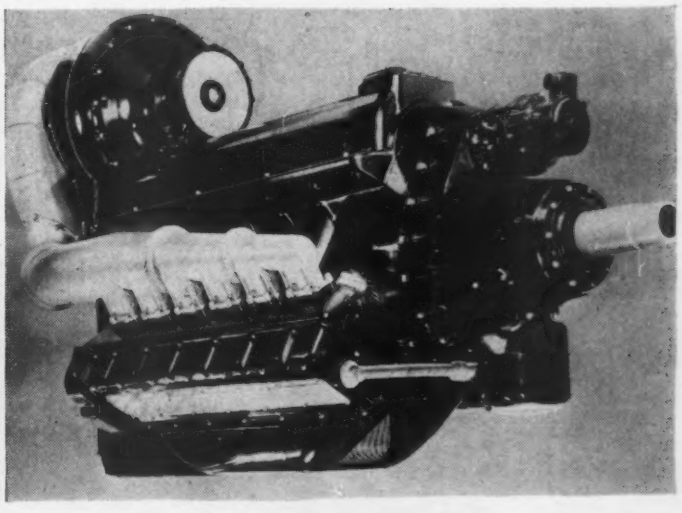


Fig. 2. (top) "Power egg" produced by the Bristol Aeroplane Co. It employs a *Hercules* engine. **Fig. 3.** (above left) Rolls-Royce, Ltd., developed this "ready-to-fly" power unit fitted with the *Merlin XX* and used on the *Lancaster 1* bomber. **Fig. 4.** (right) Ford organization's mockup of aviation integral power plant with turbosupercharger.

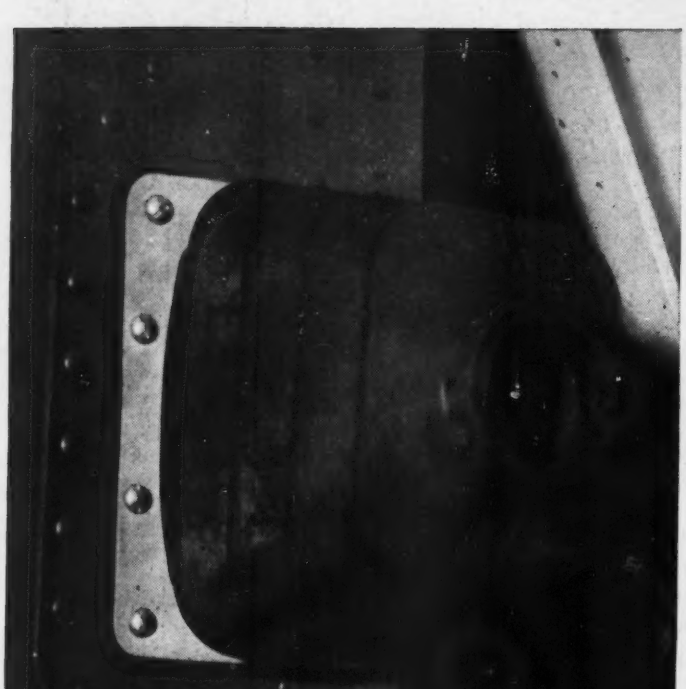


Fig. 1. Fume-proof aileron boot made of FR Neoprene (left) and with fitting (right) on Grumman TBF-1 *Avenger*. To assure free control of the ailerons at high altitudes, the rubber compound used must be one which will remain soft in low temperatures. Designed by the authors, this accordion-type bellows unit gives leeway with vari-centered holes.

New Guides to High-Altitude Rubbers*

By LT. COMDR. HARRY J. MARX, U. S. N. R., and STANLEY S. KOGUT

Bureau of Aeronautics, Navy Department

Broad needs for cold-resistant elastics in aircraft are sparking the development of more accurate testing methods — and they are also accenting the demands for a more practical terminology.

TODAY, the materials engineer is confronted, in the rubber and rubber substitute fields, with a number of new problems, each of which in itself offers opportunity for mistakes and confusion. Because of their inherent nature, they must be considered in their entirety, making the effect cumulative. These prime problems are the—

1. Need, with the advent of high altitude flying, for rubber or rubber-like materials that will resist cold.

2. Elimination, through practical means, of crude rubber as we formerly knew it and the use of substitutes with which we have not had much experience.

3. Establishment of clarity out of the great amount of confusing terminology.

Elastic properties of rubber have always been utilized by the aircraft manufacturer. Its softness and ability to flow or yield under pressure have made it suitable for a great number of purposes. As planes fly higher, the temperature gets lower. The colder it becomes, the greater the tendency of the rubber to freeze. Also because of thin air, additional fumes from high power engines, pressurized cabins, etc., a greater need arises for the multifarious use of rubber.

So we have a case of the need becoming more acute while the performance declines very sharply. Moreover, greater power and climbing speed produce exceedingly sharp fluctuations in temperature. Elastomers must maintain a reasonable consistency in many cases. At the same time, for all practical purposes, crude or so-called natural rubber, with which we have had many years of experience and with which we are extremely familiar, is being steadily removed from the realm of ordinary use.

What is commonly termed "synthetic rubber" is replacing the crude. This name for the replacement is misleading. Inasmuch as we do not know exactly what rubber is, it is quite impossible for us to have ever produced it synthetically. Actually, the thing we call synthetic rubber might be considered substitute rubber. There are a great variety of substitute rubbers some of which are somewhat similar, chemically and molecularly, to rubber and whose physical characteristics resemble that of rubber. But that is all. The fact is that we are dealing with brand new materials—a group of them rather than one. Many of the materials are identical, but for proprietary reasons they masquerade under different names. Patents are numerous, conflicting, and confusing.

At some future time it is planned to present an analysis of basic compositions and terminology in such a way that all possible confusion will be eliminated. For the present, however, we shall only attack the problem of obtaining cold

EDITOR'S NOTE: Opinions and representations in this article are those of the authors and should not be construed as reflecting the official views of the Bureau of Aeronautics. Material contained in this article is to be incorporated in a forthcoming book on properties of rubber substitutes.

resistance in rubber to permit the materials engineer to arrive at his solutions.

Cold resistance or freeze resistance is the designation of that quality or characteristic of a rubber or rubber substitute for maintaining elasticity, flexibility, and resistance to permanent set in sub-zero temperatures without cracking or developing flex checks.

Flexibility is the property of rubber or rubber substitute materials that permits their being bent. Ability of a stock to be bent is inversely proportionate to its stiffness. When its flexibility is exceeded, the material develops cracks which are generally called "flex checks." As the stock becomes colder and stiffer, it is more prone to flex checking, and by most standards of measurement a stock is considered to have failed when, at a particularly temperature, it becomes sufficiently stiff to check when subjected to a specified test.

The problem of cold resistance concerns only a portion of the rubber parts of a high altitude plane. We may first of all eliminate those parts that are so situated in or about the engines or cabin of a plane that they would not be affected by outside weather conditions.

There are also a great many uses of rubber where its properties of flexibility and elasticity are not the purpose of its utilization. A common example of this is a so-called gasket in which a layer of rubber is pressed tightly between two layers of aluminum or other metal so as to assure an air tight fit

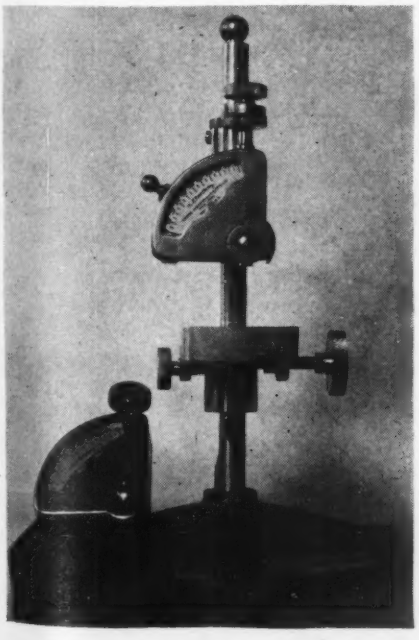


Fig. 3. Shown are two Shore durometers, the one on the left being for hardness and that on the right for elasticity. In the hardness test, the measurement on the gage is determined by the penetration of a steel pin into the rubber.

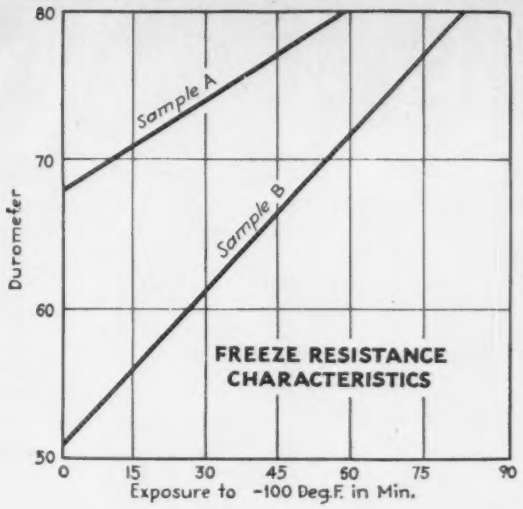


Fig. 2. This hypothetical graph indicates characteristics of rubber under cold conditions. With 80 durometer as a theoretical freeze point, a 68 durometer stock (sample *A*) becomes useless after an hour, while a stock with a room temperature reading of 51 durometer (sample *B*) lasts much longer.

or to eliminate the possibility of cracking of one of the attaching flanges or perhaps bending a bolt. We are concerned only with those rubber parts whose important ability is to stay soft and flexible under all conditions.

The term "cold flow" is very often mistaken as being a measurement of freeze resistance. Nothing could be further from the truth. Cold flow is the amount of permanent set a stock takes when subjected to pressure. It might be considered a tendency to flatten out, under any temperature condition. "Compression set," rather than cold flow, is a better term to indicate that quality.

American aircraft manufacturers, some of them quite unknowingly, are profiting very much from the experience of the Russians. On the Russian front, much colder ground temperatures have been experienced than have been felt elsewhere, often even colder than in altitude combat. It is an actual fact, however, that planes now under construction in this country are designed to fly in altitudes where coldness is perhaps more intense than that encountered in Russia on the ground. The Russian front has also brought to our attention another very interesting freeze resistance problem—

While under vibration or flexing, such as in actual flight conditions, rubber and rubber substitutes do not increase in hardness nearly as much as when they are permitted to remain without movement.

In other words, assuming we have the same temperature condition, a test sample under vibration or flexture will not become as hard as adormant one.

Today, a great many material specifications are being written which are based purely on the actions of a cold-resistant compound in a dormant test box. Cold flow properties are very often obtained in compounding at the sacrifice of other desirable characteristics—perhaps resistance to fumes, gasoline, or any number of other things. As a general rule it may be said that they are set far too low because vibration is not considered.

Aside from the number of rubber replacements and the confusion existing between the various types of rubber substitutes, we have the problem of compounding. If, for example, we specify Hycar, Neoprene, or some other elastomer in the bill of materials, we have thus indicated the base of the material. However, a variety of other ingredients must be used along with the basic rubber substitute before we achieve the finished product. The number, type, and amount of these ingredients is the basis of the physical properties of the resultant material. This art of compounding comprises a very highly specialized field about which the average aircraft man knows practically nothing.

Very often a compound must be made for a duplicity of requirements, such as for a cold condition in a hydraulic oil. The materials engineer should set up the physical requirements which must be met and then let the rubber specialists worry about the rest. Some companies are more familiar with one type of substitute than another, and there is no reason why they should not be permitted to work with those specific materials with which they are best acquainted. Generally, they are in a favorable position to tell which of the synthetics will do a better job.

When setting forth the properties of a rubber or a rubber substitute for cold operation, *specify a stock which is as soft as possible, in order to allow the greatest possible latitude before it*

Fig. 4. The arc test, comprising bending of the rubber sample around a rod, is a check for flex cracks.

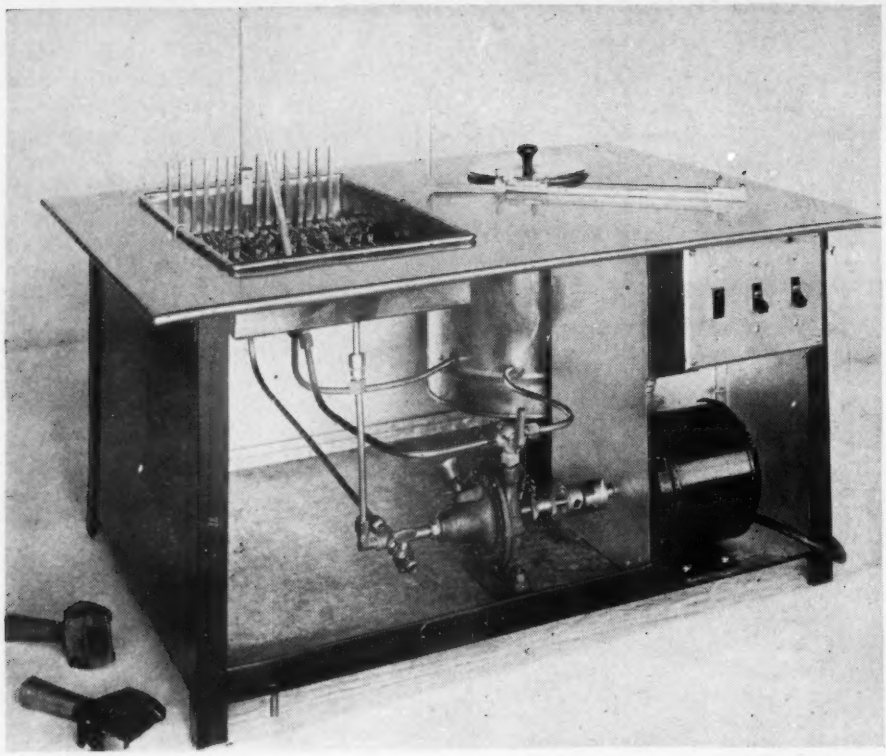


Fig. 5. Greater speed of determination of freeze resistance in rubber is provided by the Scott T-50 tester. Operator lifts knobbed lid (top) and inserts rubber sample in under-table tank holding liquid refrigerant, then takes temperature readings on thermometer (top left). A durometer is used to measure hardness after sample is reduced to desired temperature for testing.

reaches a degree of hardness which would make it unsatisfactory for its purpose.

For instance, let us assume that a rubber of 80 durometer, arbitrarily speaking, is the maximum hardness under which the unit in which it is incorporated will operate satisfactorily, and let us assume that the cold condition encountered will be severe and one under which it might be difficult to obtain a material which is sufficiently freeze-resistant. By permitting the rubber, at room temperature, to be 50 or 55 durometer, a material that will stay at 80 durometer is sometimes more readily obtainable than if 75 durometer were specified as a starting point. This consideration is very often overlooked. (See Fig. 2.)

Another excellent reason for keeping the starting point as low as possible lies in the fact that rubber is made freeze-resistant by the use of plasticizers that are extremely susceptible to evaporation under a heat condition. Should these plasticizers be lost, the action of the stock will in no way come up to its freeze-resistant expectations.

Rubber and rubber substitutes are not very good conductors of heat, and where a stock may fail because of freezing, it

(*Turn to page* 288)

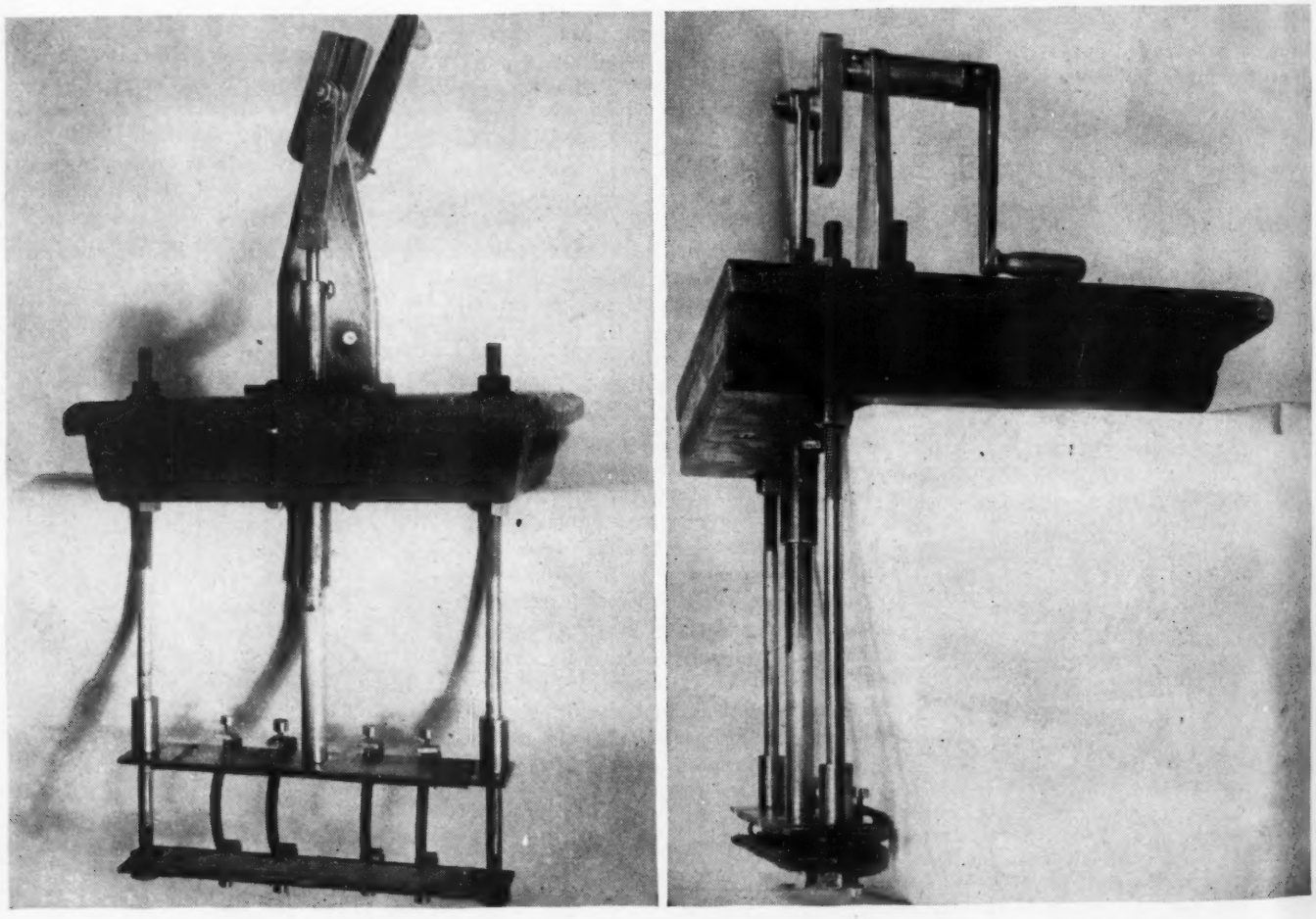
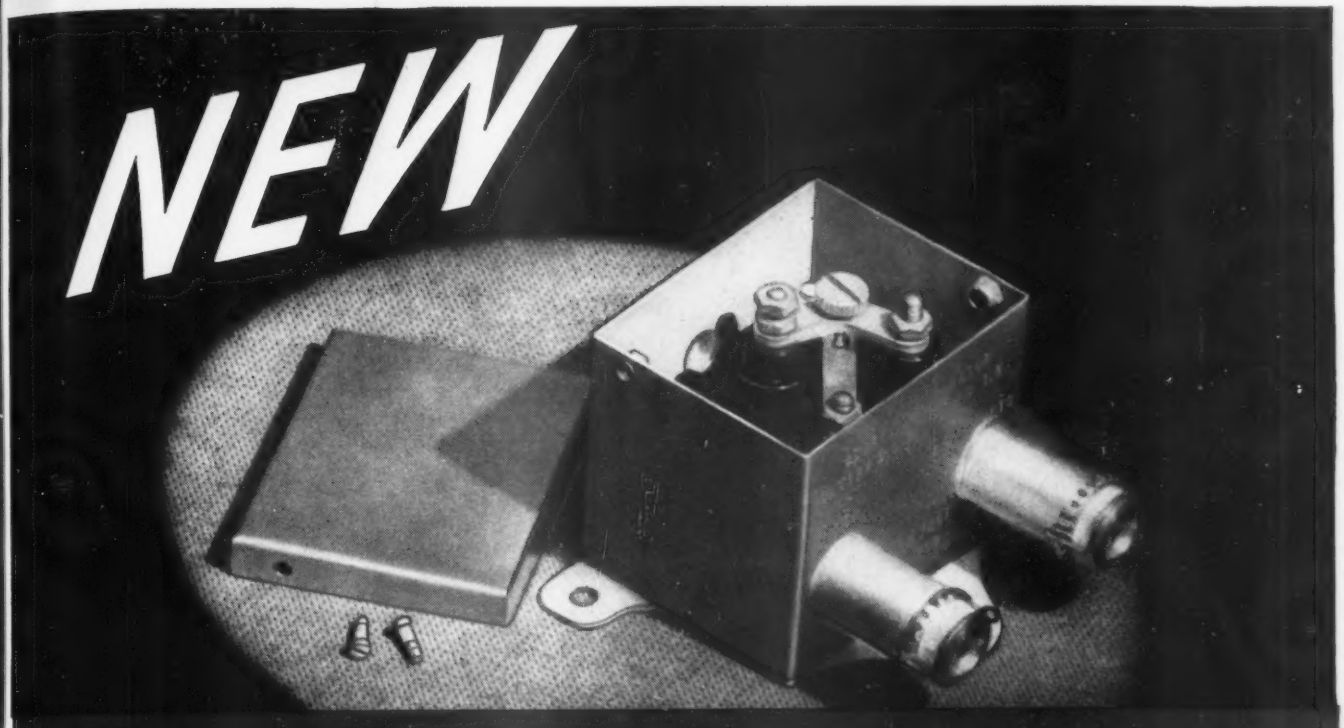


Fig. 6. Illustrated here is use of ASTM bend test machine originally developed by Thiokol Corp. Left photo shows four rubber samples (bottom) fitted to device with U-clamps. In test, turn of crank flexes samples, as seen in right photo.



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Weight: 2 pounds

For quicker, easier engine starting
REGARDLESS OF MAGNETO SPEED

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Highly efficient. Power losses are minimized, battery-current drain is low, and radio interference is almost completely eliminated. The vibrator operates only during the starting cycle; it is then automatically disconnected from the ignition circuit.

Sturdy construction. External parts are thoroughly protected against corrosion. A plated-steel case provides durability and strength. Coils are embedded in a specially developed, high-melting-point, moisture-resistant insulating compound. The vibrator is protected by a special relay against inductive voltage surges from the magneto. *General Electric Company, Schenectady, New York.*

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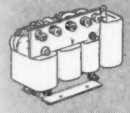
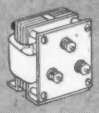

Three-phase to single-phase transformers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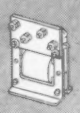
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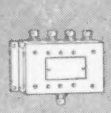
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OFF GUADALCANAL

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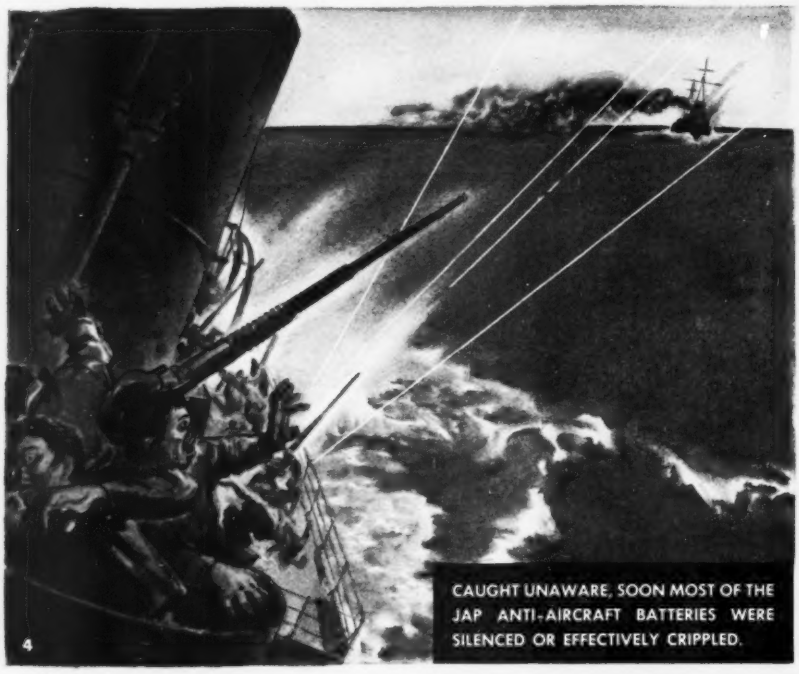
SINK JAP DESTROYERS WITH MACHINE GUNS ONLY

FOUR U. S. MARINE PILOTS IN GRUMMAN WILDCATS, RETURNING FROM PATROL TO HENDERSON FIELD AT GUADALCANAL, SPOT A BRACE OF JAP DESTROYERS SNEAKING ALONG THE COAST. ORDERED TO ENGAGE THE SURFACE CRAFT . . . WILDCATS ZOOMED UP INTO PROTECTING CLOUDS BEFORE DIVING INTO THE INITIAL ATTACK.

1



CAUGHT UNAWARE, SOON MOST OF THE JAP ANTI-AIRCRAFT BATTERIES WERE SILENCED OR EFFECTIVELY CRIPPLED.

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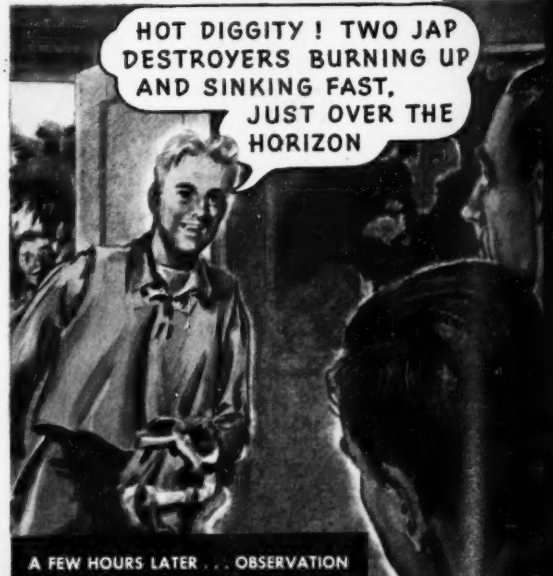
5

WITH THEIR LAST BULLETS SPENT, THE FOUR GRUMMAN WILDCATS LEFT THE DISABLED DESTROYERS FLOUNDERING IN HEAVY SEAS.

8



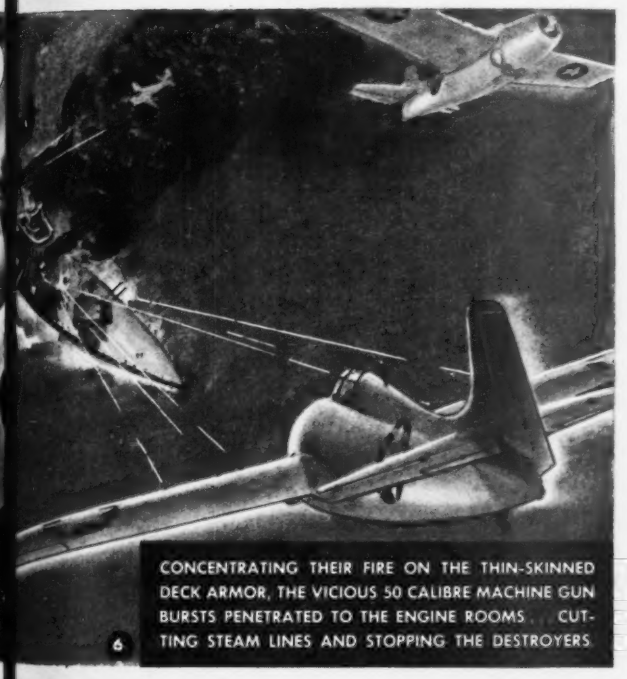
A FEW HOURS LATER . . . OBSERVATION OFFICER RETURNING FROM SEA PATROL REPORTS THE OUTCOME OF THE WILDCAT'S ENCOUNTER.

9

2

CRISS-CROSSING FROM SEVERAL DIRECTIONS AT ONCE THE LITTLE GRUMMAN FIGHTERS DOVE AT THEIR TARGETS WITH ALL MACHINE GUNS BLAZING.

3



CONCENTRATING THEIR FIRE ON THE THIN-SKINNED DECK ARMOR, THE VICIOUS 50 CALIBRE MACHINE GUN BURSTS PENETRATED TO THE ENGINE ROOMS . . . CUTTING STEAM LINES AND STOPPING THE DESTROYERS.

6

THE WILDCATS, RECKLESSLY PLUNGING IN, RIDDLED THE HEAVILY LISTING JAP SHIPS ALONG THE WATER LINE.

7

FANTASTIC AS IT SEEMS . . . THE FOUR MARINE PILOTS IN THEIR LITTLE GRUMMAN WILDCATS VICTORIOUSLY FOUGHT ONE OF THE MOST EXTRAORDINARY AND DRAMATIC ENGAGEMENTS OF THE WAR . . . SINKING TWO JAP DESTROYERS WITH ONLY MACHINE GUNS!

10

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Effect of Spinner and Cowl Entrance Combinations On Engine Cooling

By JULIUS JONAS
Power Plant Engineer, Beech Aircraft Corp.

Design of these entrance combinations has a marked effect on cooling of aircooled engines. Here are some practical suggestions, with particular emphasis on spinner design theory and effects.

IN THE COOLING of aircooled engines, it is becoming increasingly important to cut down the non-useful pressure losses. A few years ago when designers began to have a more analytical approach toward the engine cooling problem, pressure balances in the system showed excessive entrance-section losses which were readily attributed to the aerodynamic poorly designed propeller hub.

While there were considerable discrepancies of opinion as to the merits of different systems of measuring and correlating the pressures involved, it was hoped that the introduction of the spinner would afford an almost 100 percent pressure recovery. Somehow these expectations were not realized, and the innumerable tests did not extend beyond the making of recommendations based on the particular installation involved.

If it would be possible to develop a design basis for the cowl entranace-spinner combination, it is obvious that any design would be a compromise with due regard to the particular requirements of the airplane.

Let it be assumed that a representative design condition was established. The airflow, as derived from the engine cooling requirements, would determine the entrance section for any desired inlet velocity ratio. It is commonly recommended that this ratio be chosen as not lower than 0.3 and not mueh higher than 0.7. To simplify the problem, let it be further assumed that the twist imparted to the air stream by the spinner-propeller combination may be neglected. Although the efficiency of the pressure transformation is appreciably affected if a rotational velocity component exists, this assumption is not entirely unreasonable.

The rotational energy does not follow Bernoulli's equation for changing cross sections of duct flow, because it is a function of the distance from the axis of rotation. Assuming a potential flow with constant circulation, the rotational velocity component will vary inversely with the distance from the axis of rotation. Since the diameter of the spinner-afterbody combination just in front, as well as in back, of the propeller is constant for most installations, the rotational kinetic energy will, in its major part, not be transformed into static energy. This will result in a decrease of pressure recovery for high rpm. only. For low rpm. there actually will be an improvement because of the radial pressure distribution which is beneficial for the diverging flow. All other factors remaining equal, if the pressure recovery is plotted against V_o/ND, where V_o = Free stream velocity, fps.

N = propeller rps.

D = Average entrance dia. in feet.

A maximum pressure recovery will be realized at a given V/ND. It will be desirable to use this V/ND as the design V/ND. Keeping this in mind, the analysis can be approached on the basis of a translational velocity only.

The cowl entrance section, having a given inflow which for the velocity ratios mentioned above is of a diverging nature, can be considered as one particular station of a stream tube originating in the free air stream. This stream tube upon passing the plane of propeller rotation will show no appreciable increase in total pressure, particularly in high speed condition and also because the blade shanks are very nearly round within the entrance diameter of the cowling. Upon passing the plane of propeller rotation, the stream tube has to expand into the entrance section.

Introduction of the spinner into the system eliminated the prohibitive hub pressure losses and also afforded a more effective control of the inlet flow conditions. However, the spinner presented a new source of losses, which should be controlled. These losses are due to its boundary layer frequently accompanied by flow separation particularly on the top side. The spinner may be considered as built up of an infinite number of airfoils spaced radially across the spinner axis, the boundary layer characteristics of which will be a function of the angle of attack and all the other parameters commonly considered in the study of airfoils.

In normal flight attitude, particularly in climb, a positive static pressure

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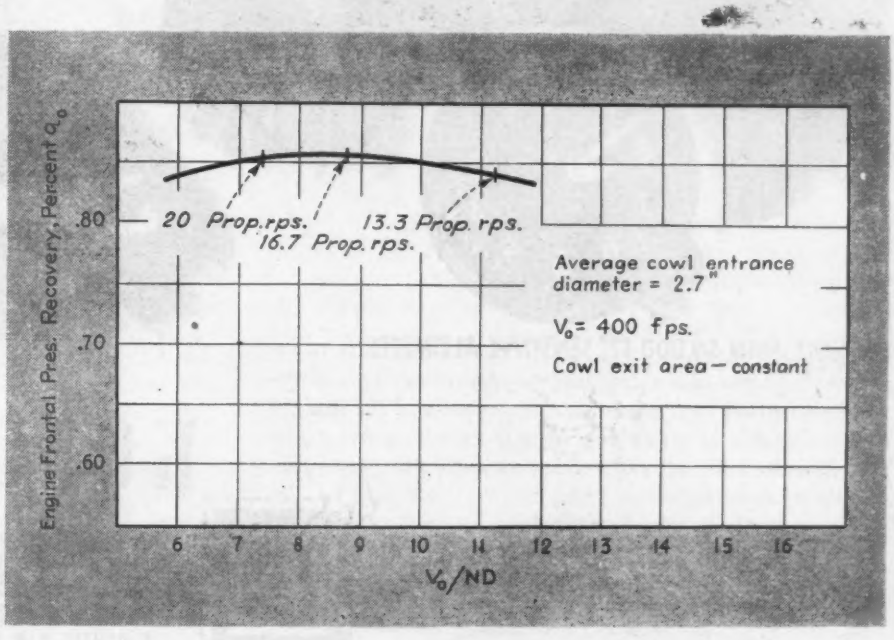

Fig. 1. Typical variation of pressure recovery with V/ND

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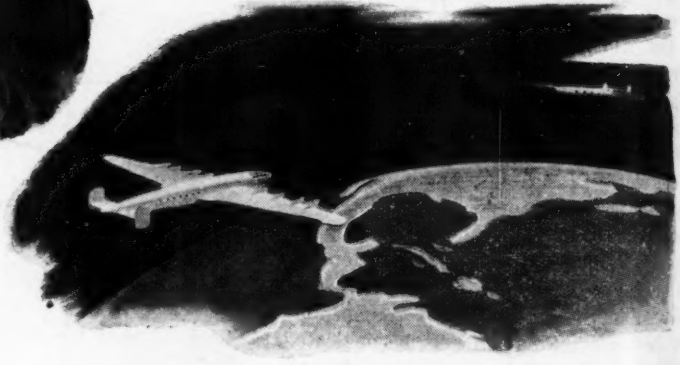
WHAT TOMORROW'S AIR TRAFFIC PROBLEMS *will be we do not yet know. But we do know that instruments will play a large part in their solution and in expanding the scope and usefulness of the airplane far beyond anything we know today. Kollsman engineers are constantly developing new and better aircraft instruments which will help widen and extend tomorrow's skyways.*



THE KOLLSMAN 50,000 FT. SENSITIVE ALTIMETER *is so ingeniously geared that a diaphragm expansion of only three-sixteenths of an inch sends the pointer around the dial 50 times! Capable of measuring altitude to within but a few feet, its essential parts are finished to within two ten-thousandths of an inch.*

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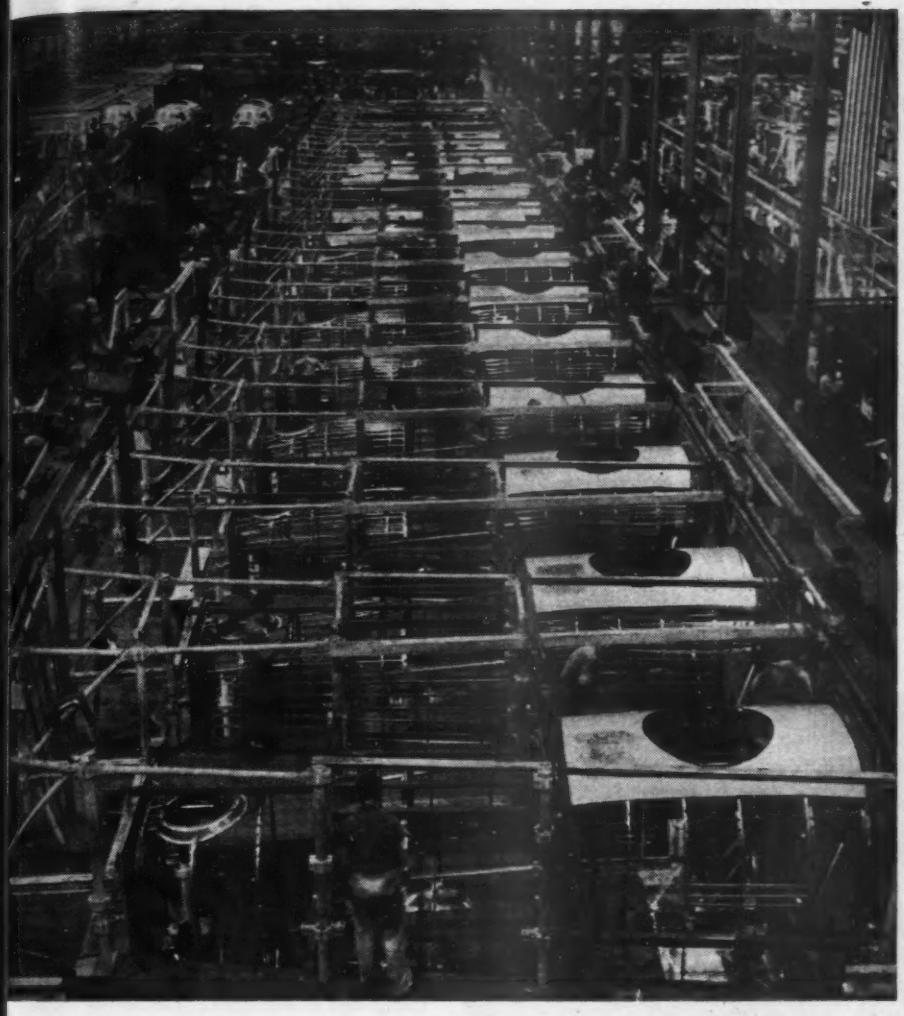
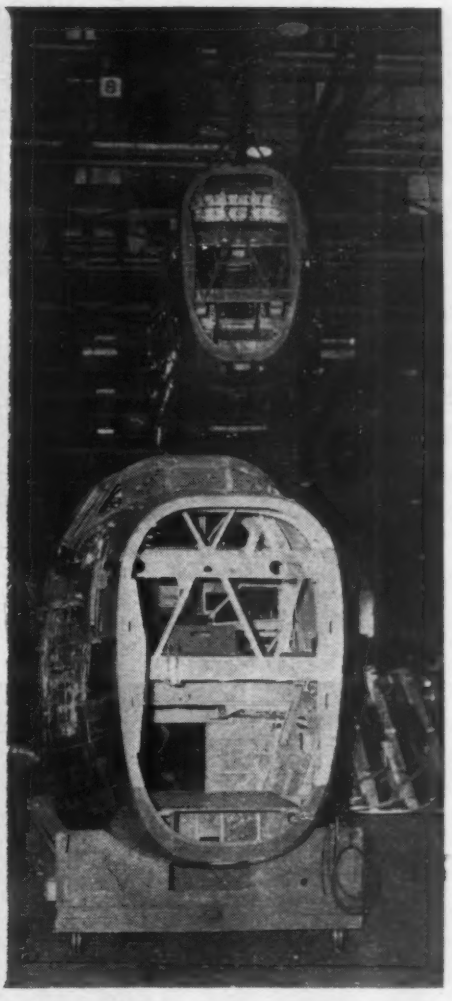


First step in building B-24 nose sections at Consolidated Vultee's San Diego plants, after basic subassemblies are formed on individual jigs, is to assemble nose section shells in stationary bucks with crews moving from section to section performing specialized operations. Four cleavage lines are left unriveted, shell being held together by bolts.



From stationary bucks, completed nose fuselage shells are lifted by overhead cranes and placed in portable cradles for rolling to disassembly station.

How *Fewer* Build *More* Bomber Nose Sections

Paradox at Consolidated Vultee San Diego plants is explained by unique break-down system plus special tooling—and production boost was achieved without vast increase in floor space.

ONLY ONE-THIRD the number of workers are now needed to turn out over 33 percent more B-24 *Liberator* bomber fuselage nose sections at Consolidated Vultee Aircraft Corp.'s San Diego plants due to an apparently complicated, yet fundamentally simple, new production system.

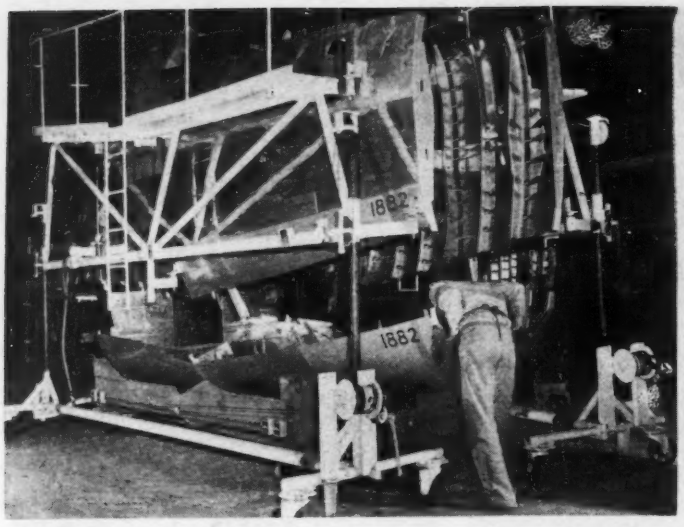
Basically the new system is this: Build the nose section shells in stationary bucks as before, cut them into four sections, make all the necessary installations on moving assembly lines, then "button" them together again.

Achieving this apparently simple result, however, was far from easy; for assembly of the fuselage nose section—literally the nerve center of the *Liberator*—is a complicated business. It entails the use of almost 700,000 parts and rivets, plus installation of roughly 13,000 ft. of wiring, 2,000 electrical and plumbing connections, and more than 2,000 ft. of tubing. Into this stubby "brain" go all the controls needed by pilot, co-pilot, navigator, radio operator, and bombardier.

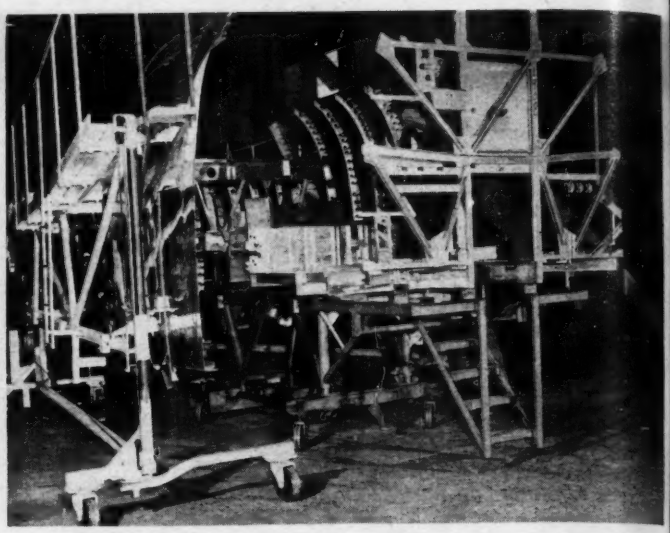
Under the original system, all these installations had to be made by crews of six workers—no more could get into the nose section at the same time and work efficiently. That meant 6,000 man-hours per unit totalling 50 working days for a crew. To meet the new production schedules would have required a subassembly line three-quarters of a mile long—for 200 fuselage noses would have to be in production at all times.

Under the new set-up, the nose section shells—running from the rear line of the bombardier's transparent enclosure to the front wing spar—are assembled in their stationary bucks as before, with one exception. This involves leaving the rivets out along four cleavage lines, one on each side from front to back just below the pilot's window, and one on each side near the bottom.

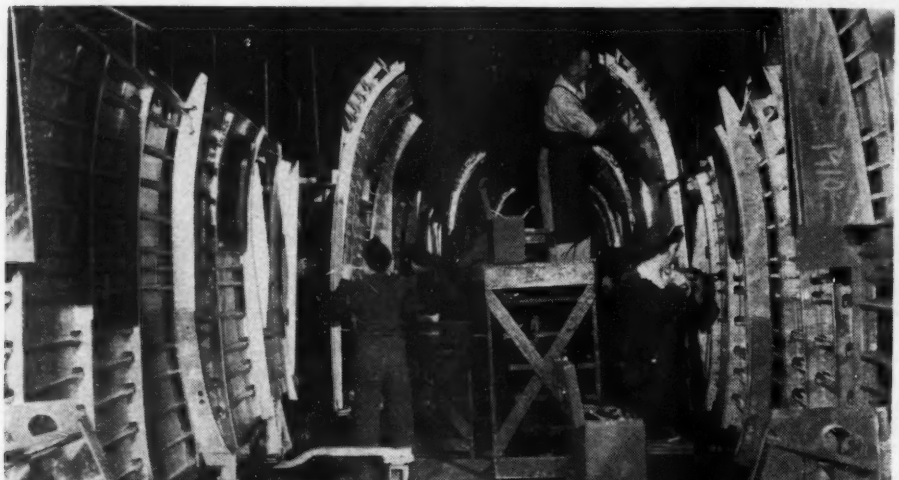
With the nose section held together by bolts at each end of these cleavage lines, the shells are lifted from the bucks by overhead crane and placed on a portable cradle. A crew of four men then moves two special rolling jigs into place, one on each side. These are



With top panel of shell removed, special white-painted rolling jigs are attached to side panels and raised by hand crank to "break" structure. Note ladder and platform built into jig, upon which side panel will remain until re-assembly of section. Bottom panels alternate with top panels on separate line.



With portable jig wheeled under flight deck (seen here between side panels) fuselage nose has been broken down into major component parts. Flight deck will receive installations on separate line. Note how axle on side panel jig can be pivoted to simplify clearance of flight deck jig.

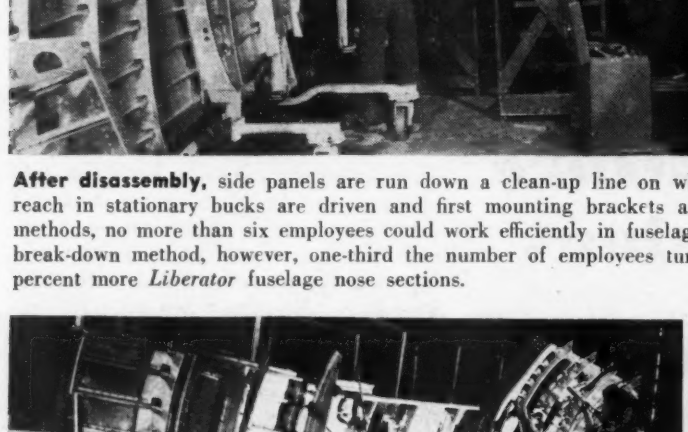


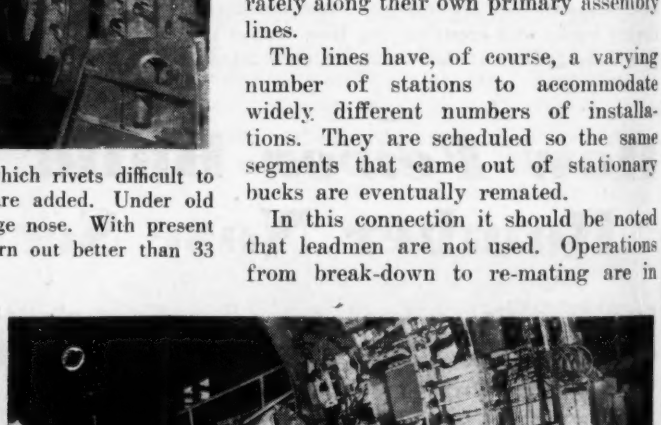
After disassembly, side panels are run down a clean-up line on which rivets difficult to reach in stationary bucks are driven and first mounting brackets are added. Under old methods, no more than six employees could work efficiently in fuselage nose. With present break-down method, however, one-third the number of employees turn out better than 33 percent more *Liberator* fuselage nose sections.

adjusted vertically by hand cranks so that pins which were bolted on the front, center, and rear of the side panels are fitted into sockets that have been bolted into place in the stationary bucks. Bolts which had held the shell together are then removed and the top panel, in turn broken into two segments, is placed in its own special rolling jig. A slight additional raising of the side panels breaks them loose from the bottom segment and flight deck. The sections, then ready to be cleaned up, proceed separately along their own primary assembly lines.

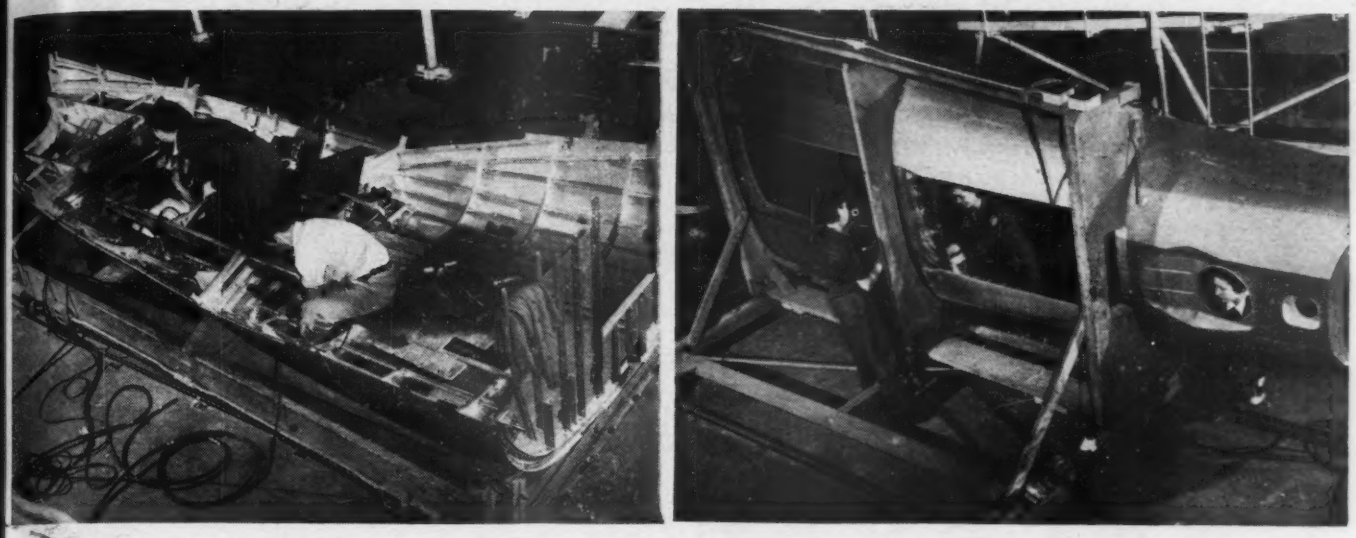
The lines have, of course, a varying number of stations to accommodate widely different numbers of installations. They are scheduled so the same segments that came out of stationary bucks are eventually remated.

In this connection it should be noted that leadmen are not used. Operations from break-down to re-mating are in





Side panels move along primary assembly line in pairs, with inside of each panel facing out to save space and relieve working conjestion. Above: Panel near beginning of primary line. Right: As it appears near end of line with most controls, wiring, and tubing in place. Note that only inside wheels of side panel jigs run on track (adjacent to line-moving chain) with outside wheels as "idlers."



Meanwhile, bottom panels move along separate line in cradles so arranged that panels can be set either horizontally (as above) or vertically (right) depending on which is most convenient for work being done in various stations. Note electric outlets built into cradles.

charge of foremen, with an assistant foreman for every five sections on the line. From re-mating to delivery to final assembly lines another foreman, with assistants, takes over.

The six sections are accommodated on four lines, one each for the side panels and flight deck with top and bottom panels and top decks alternating on the remaining line.

From break-down to re-mating, the side panels proceed along parallel lines through eleven stations, including cleanup and inspection, although installations are in many cases different. In every case, however, the jobs to be done have been broken down into the smallest possible operation, both to give speed and to keep weights light, as the lines now employ some 35 percent women, with the figure constantly going higher.

Any station, though, may see installation of a wide variety of items, ranging from elevator and aileron control brackets, sub installations involving a radio filter bracket, and de-icer control subassembly to soundproofing and heat insulation. The opposite panel, in this same station, may have comparatively simple operations, such as installation of part of the demand oxygen system, a gunner's portable oxygen bottle-holding bracket, and part of the automatic pilot elevator and aileron controls.

The job break-down for each station has been designed both to put on installations next to the skin first and to permit the maximum number of workers to operate simultaneously without crowding, or without any one employee working directly above another.

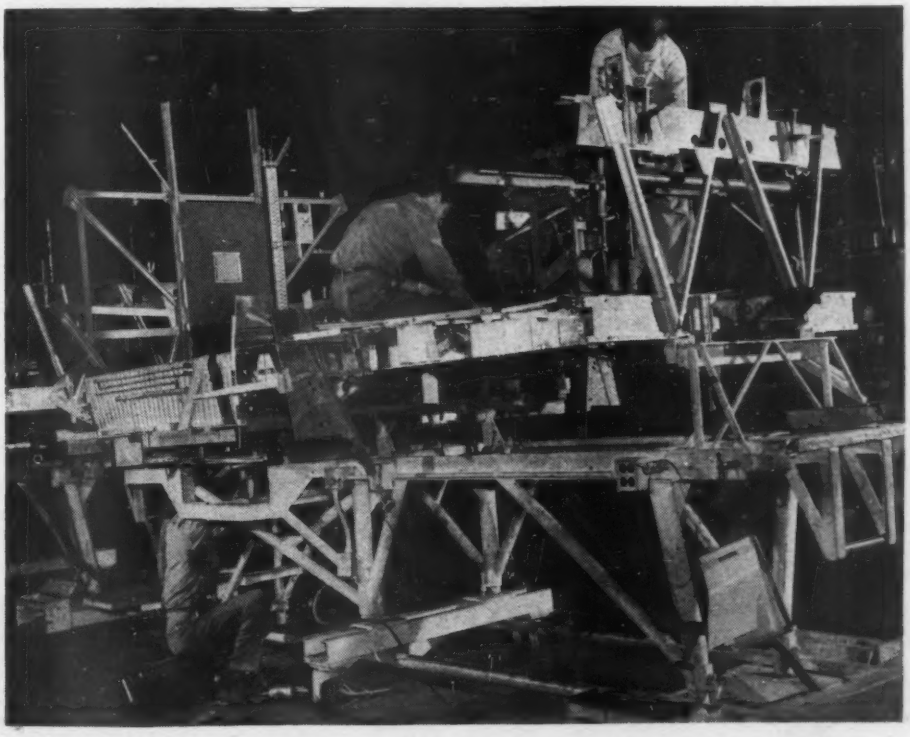
Meanwhile, the flight deck section moves through 16 stations, with Stations 8 and 14 for inspection and numbers 15 and 16 as auxiliary cleanup stations. Some of the largest installations, such as nose wheel landing gear fittings and pilots' controls, are put in on the line. The pilots' controls, including throttle and mixture control column, elevator and aileron control wheels, rudder pedals, and all control cable leads, form a complete sub-assembly.

On this line one station is exclusively for hydraulic operations, where all tubing previously installed is connected.

At the same time, the top and bottom panels move along their own line through five stations, the last for cleanup and inspection. The two segmented top panel, with comparatively few installations, is placed on its side. The fixture for the bottom panel, however, has a swiveling arrangement whereby the segment is swung on its side through the first two stations to facilitate cleanup riveting—that which could not be easily done in the buck—and to simplify initial installations.

Mating of the sections requires no special tooling. In fact the units are simply rolled from their assembly lines into an open floor area adjacent to air and electric power lines.

The side panel fixtures are moved into position alongside the cradle holding the flight deck and, by hand crank adjustments, are raised or lowered into position and fastened temporarily with bolts. Then riveting teams go to work on both sides, "buttoning up" the three units. Next, the top sections are lifted from their fixtures by hand crane and lowered into place, and the riveting oper-



Flight deck starts along primary assembly line on its own special jib which, like others, has built-in air and electric outlets.

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TO INCREASE THEIR FIGHTING POWER ★★★

White-Rodgers automatic temperature modulation equipment relieves pilots for greater concentration on fighting power by providing completely automatic control of:

1. Engine cowl flaps (both air and liquid cooled).
2. Oil cooler shutters or flaps.
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Upon request, engineering data will be furnished to manufacturers requiring controls for the above or other temperature control applications.

WHITE-RODGERS ELECTRIC CO.

SAINT LOUIS MISSOURI

LET'S GO! U.S.A. KEEP 'EM FLYING!

DOUGLAS SBD, DAUNTLESS
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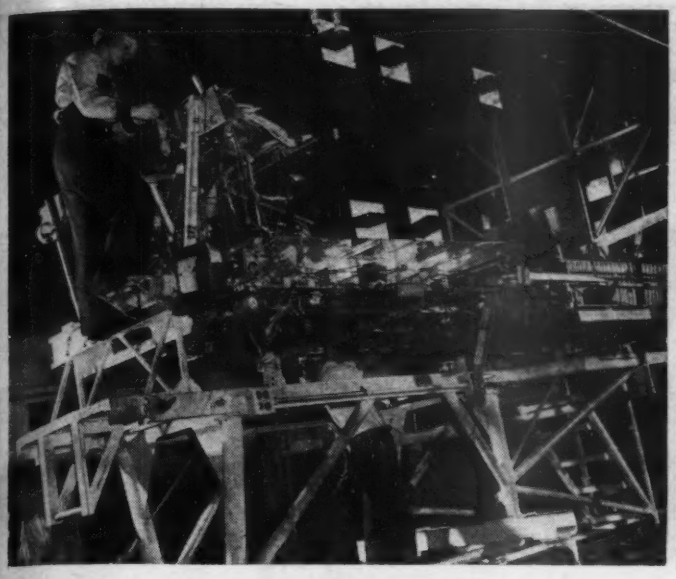
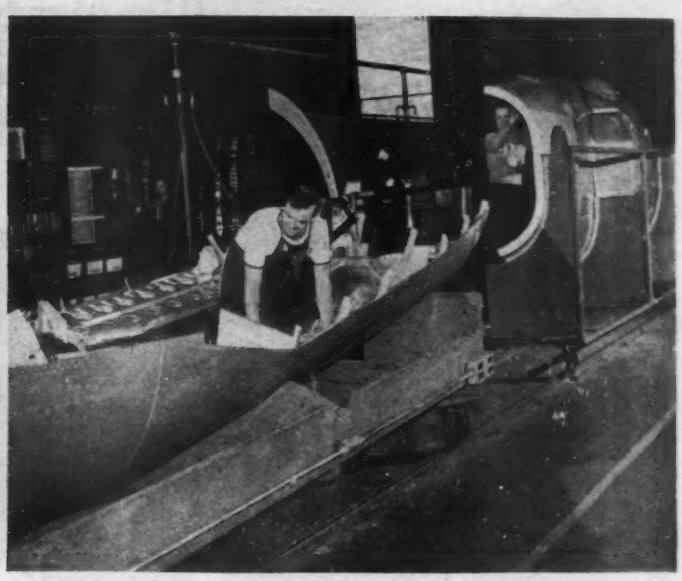
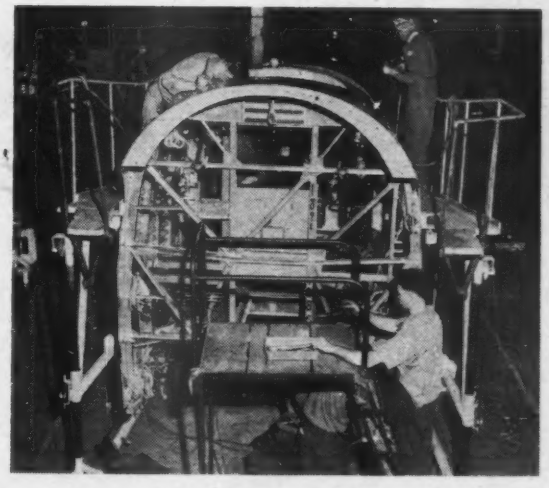


Nerve center of the *Liberator*, flight deck installations are as complicated and require as high skill as any other section of plane. Many parts, such as control quadrant, reach line as complete subassemblies which merely require installation.



Top and bottom panels move down same assembly line as alternate units, with top panel being broken in two sections. These two panels can be placed on same line because of smaller number of installations to be made.

Finishing their "runs" on primary assembly lines, panels are brought together for re-mating. Line schedules are so arranged that panels first assembled in stationary jigs are re-mated. Here side panels join flight deck—a process simply involving rolling three jigs together and "buttoning up" panels with rivet guns. There follows similar addition of top and bottom panels.



ation repeated. Finally, the bottom panel is rolled into position and riveted.

With the nose section again a single unit, it is transferred to a rolling dolly to take its place on the third mechanized assembly line. Here, moving sidewise to converse space, the nose goes through 30 stations. Since the majority of the installation work has been done in stations 5 to 16 preceding mating, these latter operations consist largely of (1) connecting electric, hydraulic, and other lines which are routed through two or more of the segments; (2) making such installations as can be put in only when the nose section is one unit; (3) putting in windshields, astro-dome, and bombardier's enclosure; (4) finishing all fabric, upholstery work, etc.; and (5) cleanup and inspections.

From the end of this line, the section goes to the special paint shop. It is then moved by special truck-trailer to the final assembly area where it is joined to center section and aft fuselage.

Today, then, instead of a subassembly line three-quarters of a mile long, only a few hundred feet of factory space are required for fuselage nose assembly. Instead of 6,000 man-hours far less than 1,000 are now needed. By these and similar improvements in the handling of men and materials, Consolidated Vultee is keeping *Liberator* bombers rolling in ever increasing numbers off the production lines at both its San Diego and Fort Worth plants.

Following re-mating, fuselage nose sections move sidewise in cradles along final assembly line, where myriad instruments, controls, wiring, and tubing systems, installed in different panels, are fully integrated.

With addition of coat of paint, applied in paint room at end of assembly line, nose section is ready for transfer to another plant, where it will move into final assembly line for integration with remainder of fuselage and center section.

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TUBE
CYLINDER BARRE

engines perform better!

THE enlarged photomicrograph* shown opposite is an actual 1000-X magnification of metal structure in an aluminum piston *forged* by TUBE TURNS.

The pilot is not a metallurgist, yet he realizes that *excellent metal structure* like this is important to his success.

No engine part demands more production skill than *pistons* and *cylinder barrels*. Accurate forging, coupled with skillful *heat treating*, gives these vital parts the exact hardness and metal structure so necessary to quality and endurance.

Years of forging "know how" and the most modern equipment enable TUBE TURNS to set an enviable record in forging these crucial parts with the *perfection* and *speed* demanded by engine manufacturers — so that American planes and their crews may perform better!

**This Tube Turns photomicrograph is of a sample of 18-S aluminum alloy, quenched in boiling water after soaking at 960°F. for 6 hours. It was then reheated to 340°F. for 8 hours. Etched in Kellar's reagent for 15 seconds. Magnification 1000-X.*

TUBE TURNS (Inc.), LOUISVILLE, KY.

A Small Tube Turns Steel Cylinder Barrel Forging.

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and ALUMINUM PISTON FORGINGS

Super-Aluminum Alloys For Aircraft Structures

PART II

By KENNETH R. JACKMAN,
Chief Test Engineer, Engineering Test Laboratories, San Diego Div., Consolidated Vultee Aircraft Corp.

Analyzed here is the vital importance—as revealed by extensive research—of temperature of "time at temperature" in raising tensile and compressive strengths of sheets, extrusions, and rivets. Second of our special series for design and production engineers.

TESTS made by the CVAC laboratories at San Diego in 1937 and again in 1940 [17, 19] indicate that 24S alloys, when subjected to temperatures from 350–450 deg. F. experience a notable increase in tensile and compressive yield strengths. The precipitation phenomenon accounting for this valuable increase appeared to be a function of both *temperature* and *time at temperature,* many hours being necessary to complete the aging at 350 deg. F., while less than one hour was required at 450 deg. F.

Early tests were made at 350 and 355 deg. F., inasmuch as the holding times at temperatures above 350 deg. F. were of short duration and consequently the reproducibility of results, necessitated for ease of production control, might be poor.

The preliminary investigation also indicated that the precipitation was more complete and the increase in yield strength was proportionately greater, when the material had been subjected to a cold-working process before the aging or "cooking" treatment.

Inasmuch as CVAC developed, and has for some years used, the prestressing process designed to work-harden and increase the mechanical properties of the 24ST material by uniformly stretching it to a permanent elongation of 3½ percent, it was decided in these earlier investigations to confine the research principally to Alclad 24ST so processed. The designation used by Consolidated Vultee for this 3½ percent pre-stretched product is "Alclad 24RT". Fig. 12 presents a schematic flow chart of the 24S material through its several processes and lists the presently accepted designations. The CVAC material designation "Alclad 24RT" should not be confused with material work-hardened by rolling and designated by the Aluminum Co. of America as "Alclad 24SRT".

The heat treatments of specimens shortly to be discussed were conducted in large production tanks containing molten sodium nitrate, and they were held at a constant temperature of 930 deg. F. for the necessary soaking time of 45 to 60 min. From this temperature they were quenched in cold water.

The aging treatment consisted of subjecting the test material to a temperature of 350 deg. F. (or 365 deg. F. in more recent tests) for the specified lengths of time. All material was air cooled from this temperature, unless otherwise noted. This aging process was conducted, in preliminary tests, in tanks containing a molten mixture of 50 percent sodium nitrite and 50 percent potassium nitrate held at the desired temperature. More recent test specimens were aged in a large air oven.

Standard ½ in. tensile coupons were made from sheet or roller stiffener material which had been processed by stretching, by aging, or by a combination of stretching and aging. The tensile coupons were tested on a 120,000-lb. hydraulic testing machine, using an autographic stress-strain recorder.

The results of tests varying the time in a salt bath at a temperature of 350 deg. F. are shown in Fig. 13. Very evident is the amazing increase in the tensile yield stresses between the heat-treated 24SO Alclad aluminum alloy sheet coupons and this same material pre-stretched to a 3½ percent permanent set. The heat-treated .091 in. 24SO Alclad before aging had a tensile yield stress of 39,000 psi.; stretching this material to a 3½ percent set produced a tensile yield stress of 51,000 psi., or a 30 percent increase. Aging the original

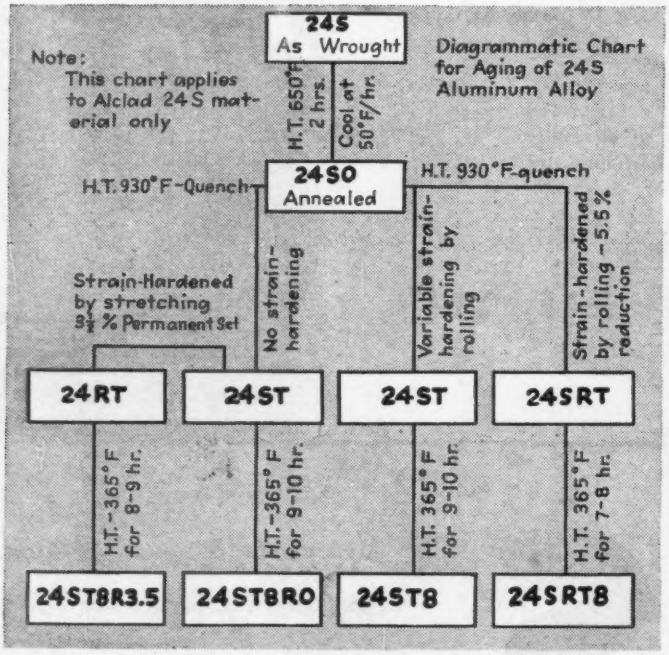


Fig. 12

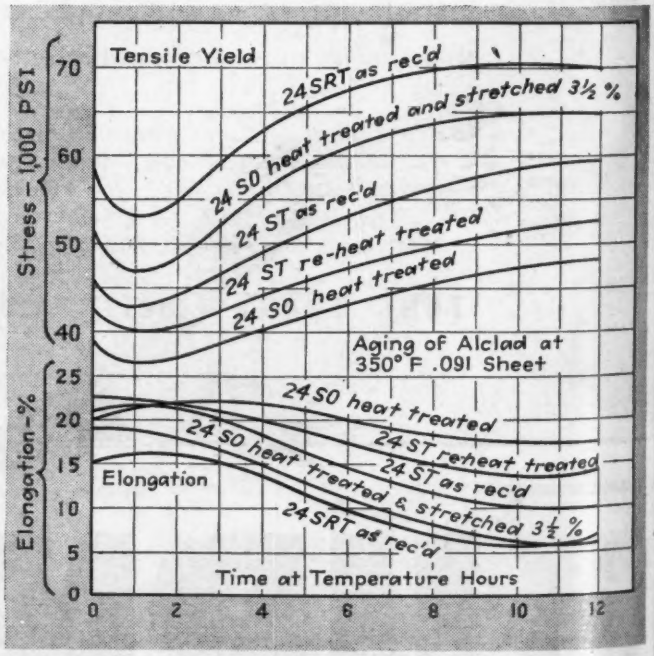


Fig. 13

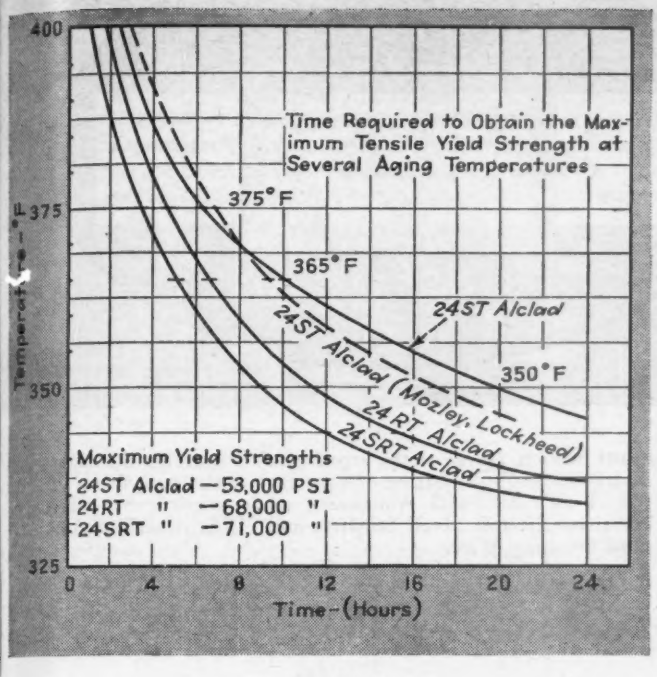


Fig. 14

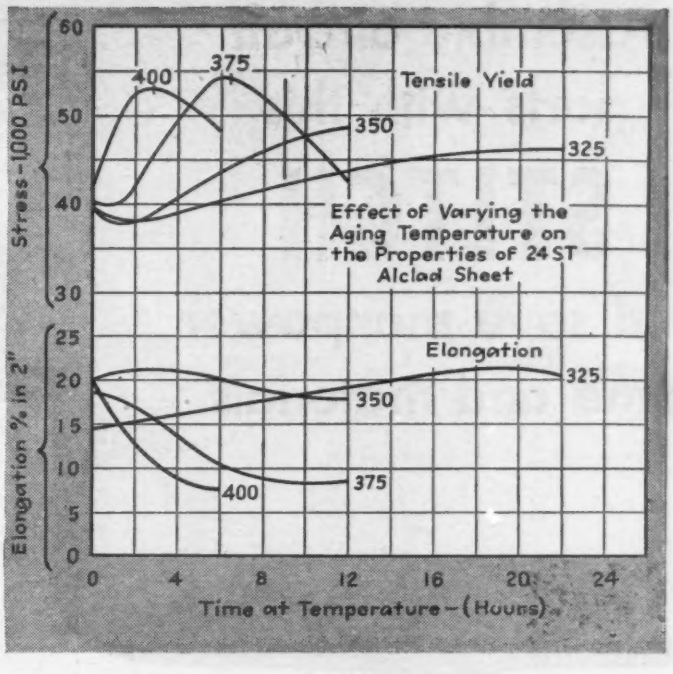

Tensile Yield
Effect of Varying the Aging Temperature on the Properties of 24ST Alclad Sheet
Elongation
Stress — 1000 PSI
Elongation % in 2"
Time at Temperature — (Hours)

Fig. 15

material at 350 deg. F. for 10 hr. produced a 47,000 psi. tensile yield; aging the 3½ percent pre-stretched original sheet for a similar period at 350 deg. F. raised the tensile yield to approximately 65,000 psi., or a 66 percent increase.

Were the 24ST reheat-treated samples of Fig. 13 to be "soaked" for a sufficient length of time (possibly 4 to 8 hr.) it is possible that the 24S reheat-treated curve would approximate the 24SO heat-treated curve.

The elongation of 20 percent on these particular 0.091 in. sheet coupons of the heat-treated 24SO was reduced to 17 percent after aging 10 hr. Aging the 3½ percent stretched material reduced the elongation to 6 percent, a value still very serviceable for most aircraft design uses.

Fig. 14 shows the time required to obtain the maximum tensile yield strength at several aging temperatures for 24ST Alclad, 24RT Alclad, and 24SRT Alclad. The two important variables, "temperature" and "time at temperature," to obtain maximum yield strengths in 24S alloys, form a family of curves. However, it may be seen that the maximum tensile yield stress of 53,000 psi. for 24ST Alclad may be obtained by aging the material for 20 hr. at 350 deg. F., 10 hr. at 365 deg. F., or 6½ hr. at 375 deg. F.

Likewise, the 68,000 psi. maximum tensile yield stress for 24RT may be obtained by 11½ hr. soaking at 350 deg. F., 6½ hr. at 365 deg. F., or 4½ hr. at 375 deg. F. The curve recently published by Mozley[28] has been dotted on Fig. 14 and indicates a close check of the earlier CVAC findings in the 365 deg. F. temperature range. It is of interest to note that the CVAC 24ST Alclad curve of Fig. 14 is based on heat-treated 24SO Alclad, whereas the Lockheed curve[28] (dotted) is based on test data obtained from 24ST Alclad "as received" sheet. It would therefore appear logical that the Lockheed curve should lie between the CVAC 24ST Alclad and 24RT Alclad curves throughout its length.

Effect of varying the aging temperature on the tensile yield and elongation

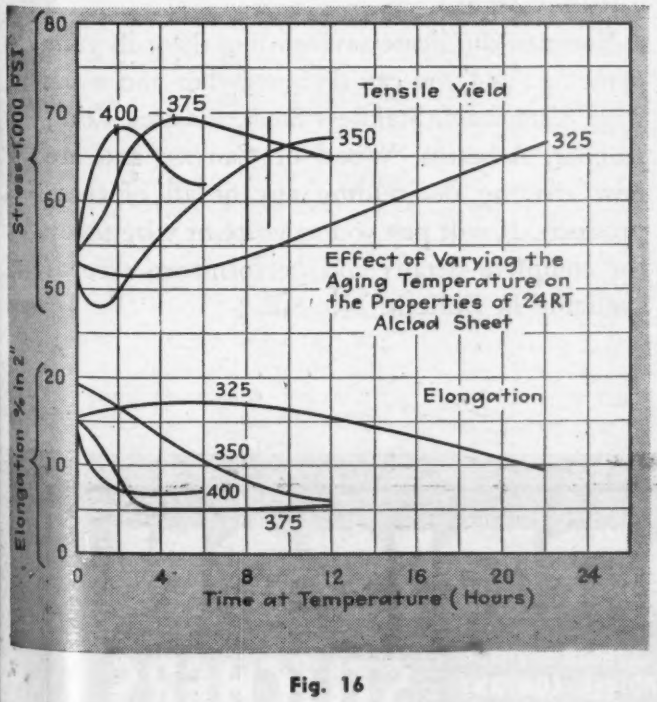

Tensile Yield
Effect of Varying the Aging Temperature on the Properties of 24RT Alclad Sheet
Elongation
Stress — 1,000 PSI
Elongation % in 2"
Time at Temperature (Hours)

Fig. 16

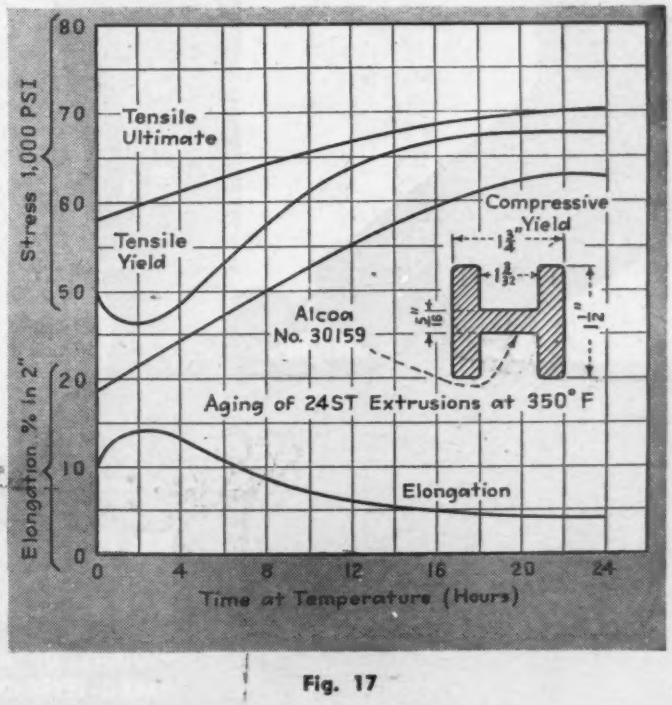
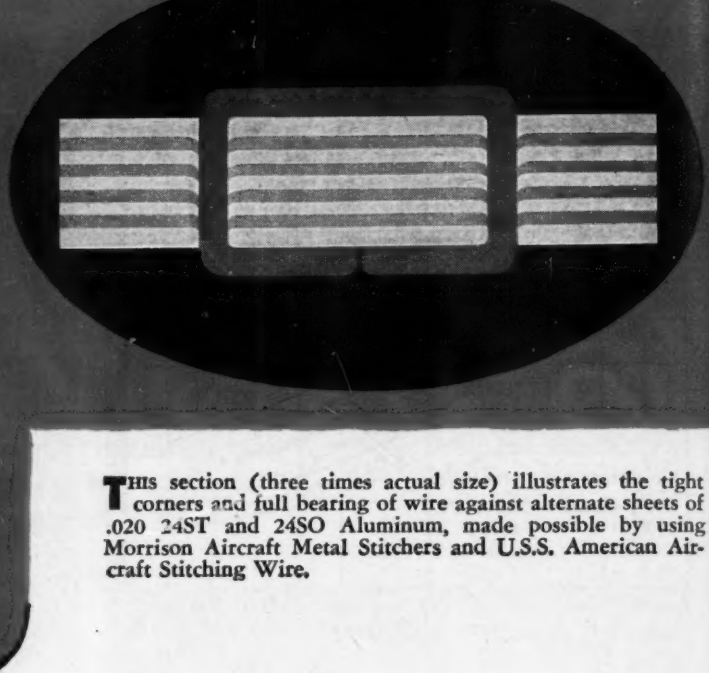
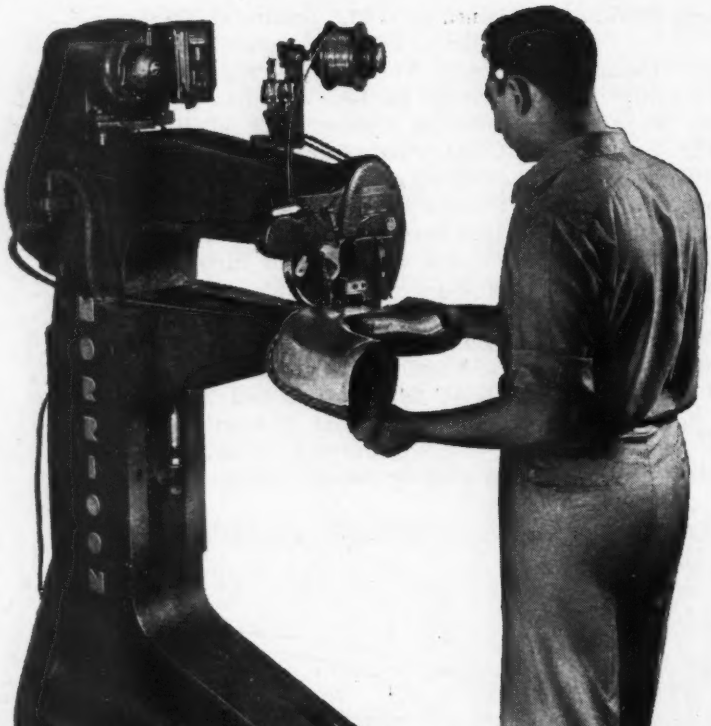


Fig. 17

Assemble aircraft parts with this STITCH and save manpower time and materials



THIS section (three times actual size) illustrates the tight corners and full bearing of wire against alternate sheets of .020 24ST and 24SO Aluminum, made possible by using Morrison Aircraft Metal Stitchers and U.S.S. American Aircraft Stitching Wire.



Savings in manpower, time and material by use of Morrison Aircraft Metal Stitchers and U.S.S. American Aircraft Stitching Wire are truly amazing. Unusually high-tensile-strength wire gives the required penetration in aluminum sheets and other metal parts. An especially developed and applied zinc coating protects against corrosion. It is government approved for fastening many aircraft parts.

With the development of Morrison Aircraft Metal Stitchers, remarkably fast and economical application of this new wire has been achieved. Actual man hours were cut over 86% on the first five applications converted to stitching at Curtiss-Wright.

You can duplicate savings like these in your plant . . . and you can do it whether you work with Aluminum, Stainless Steel, Plastics, Cork, Rubber, Asbestos, Wood or Canvas, and are now riveting or welding any or all of these products. It will pay you to write or wire today for complete details and performance records available in Bulletin No. 8-F.

MORRISON STITCHERS

PRODUCTS OF THE SEYBOLD DIVISION
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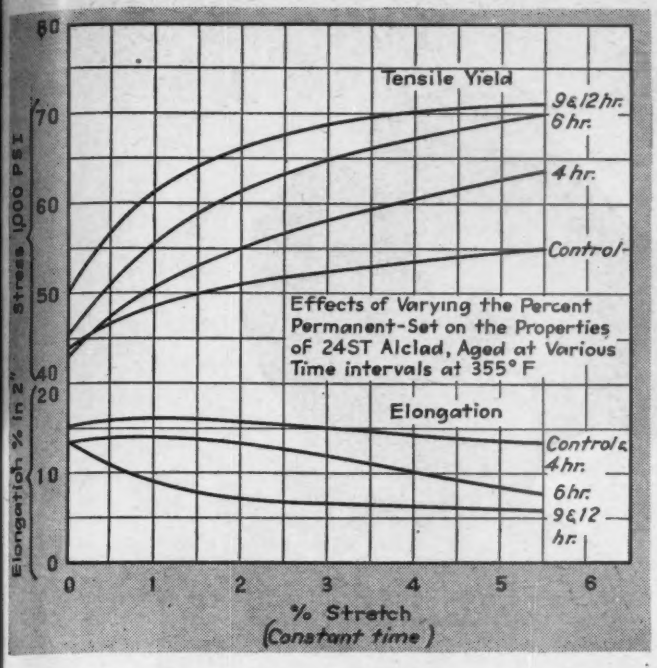

Fig. 18

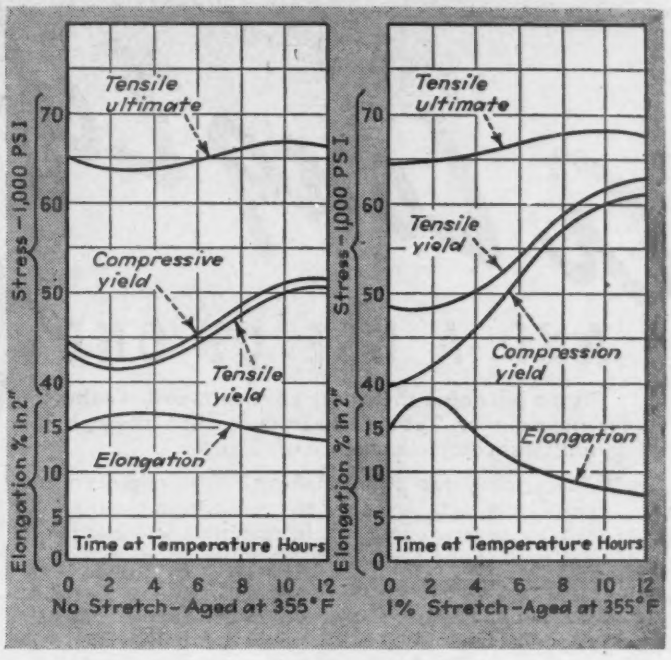

Fig. 19

of 24ST Alclad sheet is shown in Fig. 15. It is evident from this chart that the critical slopes of the higher aging temperatures make it desirable to choose a standard procedure for aging at a temperature below 375 deg. F. The recently approved temperature tolerance of 365 deg. F. ± 50 deg. F. for 9 to 10 hr. to produce *24ST8 Alclad* from *24ST "as received" Alclad* appears to be a good compromise between the long aging, with adequate control, at 350 deg. F. and the shorter aging, with poor production control, at 375 deg. F. or higher.

Fig. 16 gives a similar set of curves for 24RT Alclad sheet aluminum alloy. Again, the recently-adopted standard for converting *24RT Alclad to 24ST8R3.5 Alclad*, by aging at 365 deg. F. ± 5 deg. F. for 8 to 9 hr., appears reasonable.

Aging of 24S Extrusions

Aging may also materially benefit 24S aluminum alloy extrusions. Fig. 17 gives the physical properties on coupons cut from a 24ST Alcoa No. 30159 extrusion. The tensile specimens were ¼ in-dia. test bars, and the compressive coupons were machined out of the extrusion in 3½ in. lengths for the "sandwich" method of testing. The tensile and compressive yield strengths of "as received" 24ST extrusions are increased approximately 17 percent and 33 percent, respectively, by aging at 350 deg. F. for 7½ hr. Tensile and compressive yield strengths of 3½ percent stretched and aged extrusions are increased approximately 46 percent and 69 percent, respectively, as compared with "as received" extrusions.

Elevated Temperature Aging at 355°F.

Effects of varying the percent permanent set, on the tensile properties of 24ST Alclad aged for various time intervals at 355 deg. F., are shown in Fig. 18. It is of interest to find that the 9-hr. aging curve produces maximum tensile yields for a given percent pre-stretch on this 24ST Alclad sheet, and that 12-hr. aging can produce no appreciably better results.

On Figs. 19 and 20 are plotted representative property curves for no stretch., 1 percent stretch (approximating 24ST "as received"), 3½ percent stretch, and 5½ percent stretch (approximating 24SRT "as received"). It is interesting to note, on Fig. 19, that the yield stresses in tension and compression on the "unstretched" material were 43,500 psi. and 44,500 psi., respectively, and that the material maintained this 1,000 psi. differential throughout the 355 deg. F. aging cycle up to 12 hr. Elongation varied from 16½ percent in a 2 in. length, to 14 percent, at 10 hr. aging. The 24S Alclad sheet that was stretched to 1 percent permanent set showed (as noted in Fig. 19) that the initial tensile yield stress rose to 48,000 psi., while the initial compressive yield stress fell to 39,500 psi. The two curves rapidly approached each other and maintained a 1,500 psi. spread from 6 to 12 hr. of aging. The maximum elongation of 18 percent in a 2 in. length after 2 hr. of aging was reduced rapidly to 8 percent after 10 hr. The 3½ percent stretched 24S Alclad sheet indicated a compressive yield of 43,000 psi. and a tensile yield of 53,000 psi.

Again the upper portions of the two curves paralleled each other, separated by 1,500 psi. Elongation was reduced to 6 percent after 10 hr. Note that the ultimate shear curve at 3½ percent permanent set remained almost constant at 42,500 psi., and the tensile yield was 55,000 psi. The two curves again paralleled each other at the longer aging periods. Note how little difference exists between tensile yield and ultimate on the longer-aged portions of the right chart. The elongation in 2 in. on this chart descended to 5½ percent. Summarizing Figs. 19 and 20, therefore, extreme property changes may be noted between "no-stretch and no-age" and "5½-percent stretch and 10 hr. aging," as shown in the accompanying Table III.

TABLE III

Fig. No.	Treatment	F_{tu}	F_{ty}	F_{cy}	Elong. (in 2 in.)
19	"No-stretch and no-age"	65,000	43,500	44,500	14½%
20	"5½%-stretch and 10-hr. age"	73,000	72,500	71,500	5½%
	Percent Change	+12%	+66%	+61%	−62%

The effect of varying the aging time, on the properties of 24RT Alclad stretched at various intervals after quench, is shown in Fig. 21. The cross-hatched areas represent the spread of test values obtained from coupons stretched ¼ and ½ hr. after quench, and from coupons stretched 4, 6, 8, and 48 hr. after quench. Inasmuch as the test data were scattered over the areas shown with very little order, it may be surmised that the speed with which the stretching operation follows the quench is relatively unimportant.

Points on Aging 24S Aluminum Alloys

In applying laboratory findings on stretching and aging 24S sheet and shapes to the production line, there are many important points which must be remembered if consistent and reproducible results are to be obtained.

CVAC tests indicate that approximately ½ percent spring-back exists in

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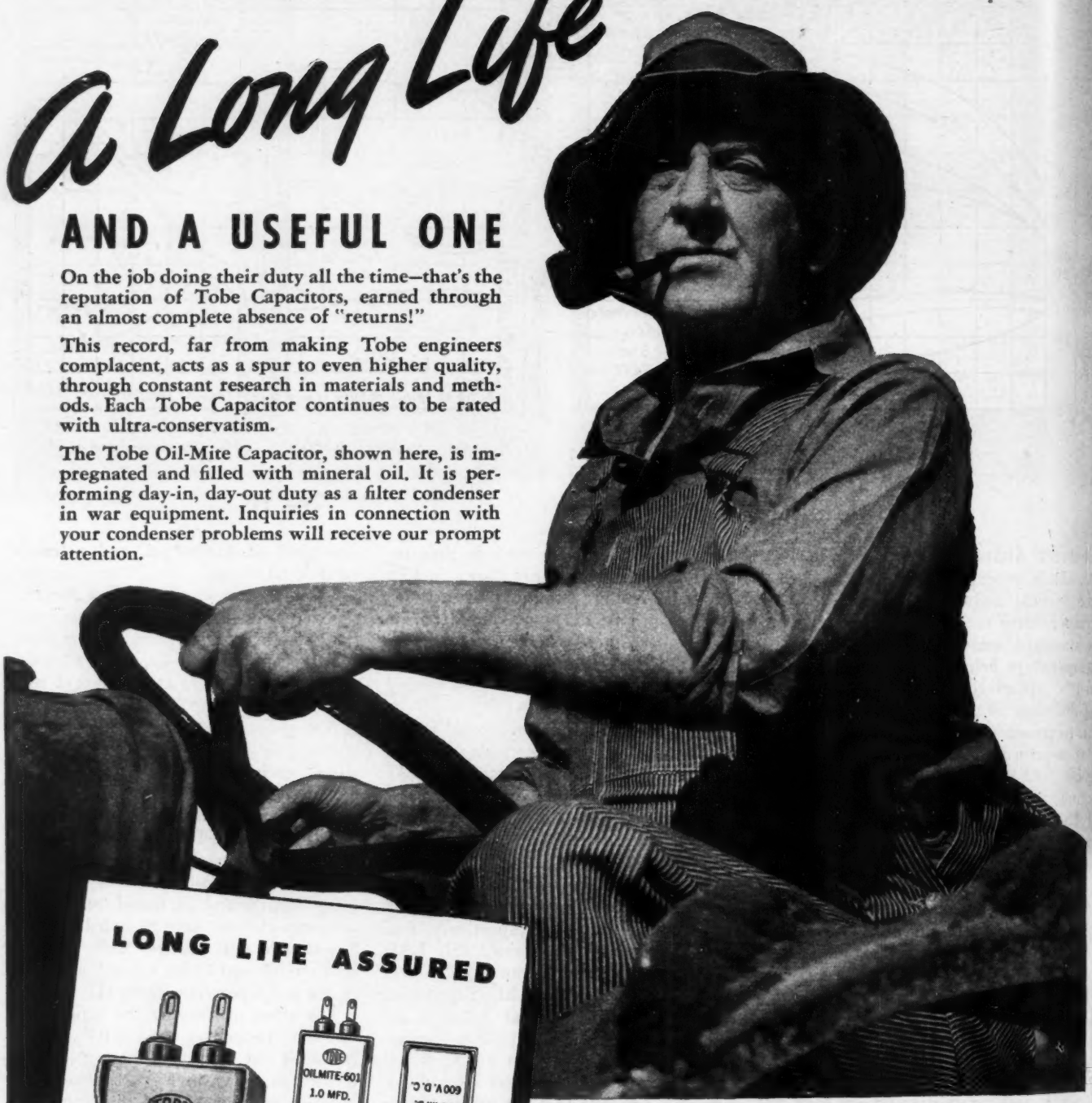
AND A USEFUL ONE

On the job doing their duty all the time—that's the reputation of Tobe Capacitors, earned through an almost complete absence of "returns!"

This record, far from making Tobe engineers complacent, acts as a spur to even higher quality, through constant research in materials and methods. Each Tobe Capacitor continues to be rated with ultra-conservatism.

The Tobe Oil-Mite Capacitor, shown here, is impregnated and filled with mineral oil. It is performing day-in, day-out duty as a filter condenser in war equipment. Inquiries in connection with your condenser problems will receive our prompt attention.



LONG LIFE ASSURED

Note new hold-down bracket that allows inverted or upright terminals. Takes less space and permits wiring either underneath or on top of chassis.

CHARACTERISTICS OF TOBE OIL-MITE CAPACITORS

STANDARD CAPACITY TOLERANCE.	= 10%
TEST VOLTAGE	Twice D.C. rating
SHUNT RESISTANCE	.05 to 0.1 mfd. 20,000 megohms. .25 to 0.5 mfd. 12,000 megohms. 1.0 to 2.0 mfd. 12,000 megohms
RATINGS	.05 mfd. to 2.0 mfd. 600 V.D.C. .05 mfd. to 1.0 mfd. 1,000 V.D.C.
GROUND TEST	2,500 Volts D.C.
POWER FACTOR	At 1,000 cycles—.002 to .005

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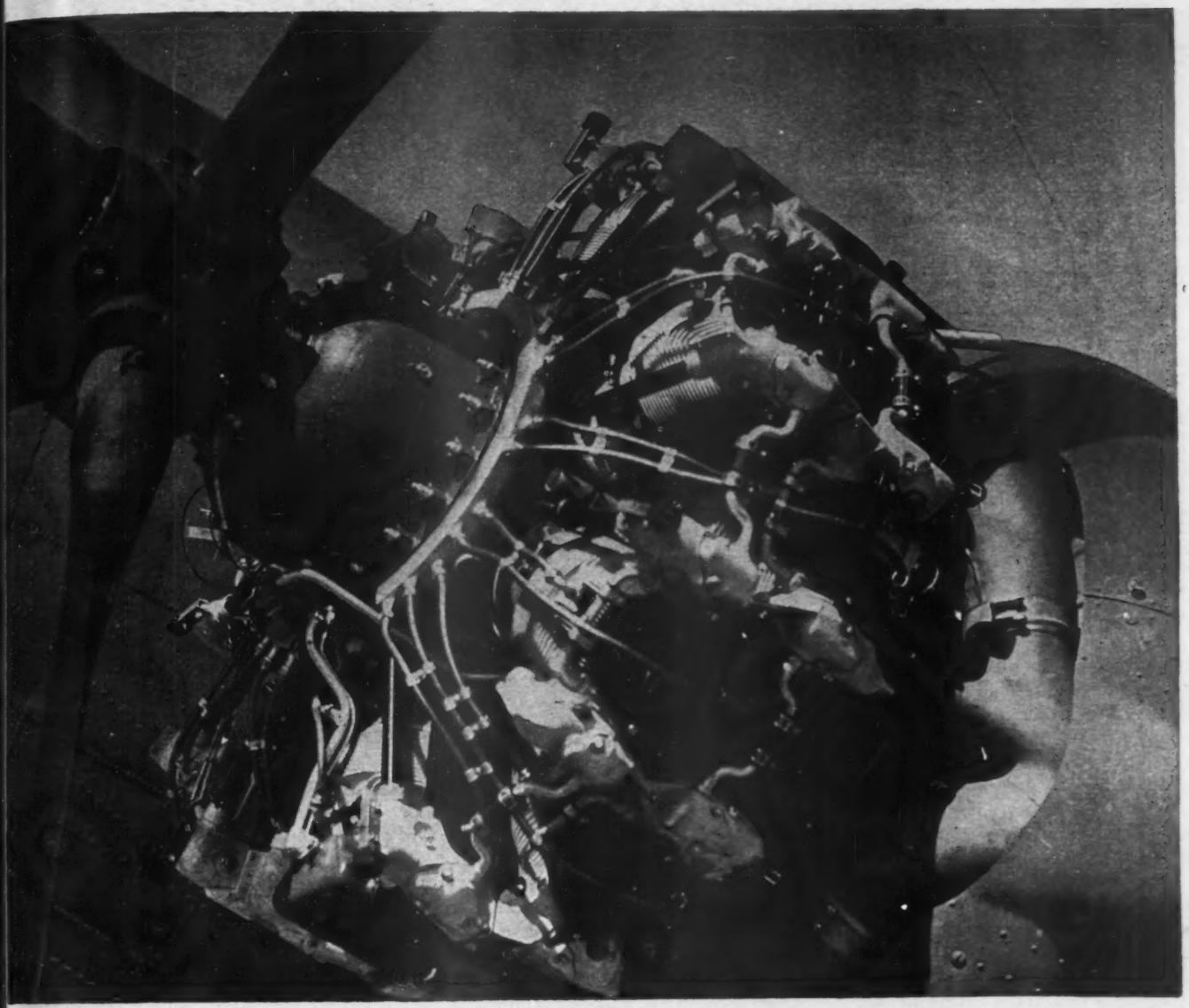
A SMALL PART IN VICTORY TODAY—A BIG PART IN INDUSTRY TOMORROW



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After more than 18 months of war, stainless steel stands out as the only metal that holds its own in the punishing exhaust systems of high-powered warplanes. One of these rustless alloys that is being war-proved on every battlefront is ARMCO Stainless.

This is why ARMCO Stainless must be Spartan-tough. In endless hours of combat flying, red-hot corrosive gases roar through the stainless steel collector systems of big bombers and speedy fighters. The great vibrating engines would tear ordinary materials to pieces, yet this heat-resisting metal takes it all and comes back for more.

You'll approve these other advantages of ARMCO Stainless Steels too: They form easily and can be fabricated by the fast spot-welding process. The strength-weight ratio is exceptionally high. No heat treatment is needed to develop exceptional physical properties.

If you make planes or parts for the Allies' air armadas — or if you are thinking of future structural uses for metal—consider using ARMCO Stainless Steels. There is a grade for every requirement. Write to The American Rolling Mill Company, 2361 Curtis Street, Middletown, Ohio.

ARMCO STAINLESS STEEL

THE AMERICAN ROLLING MILL COMPANY

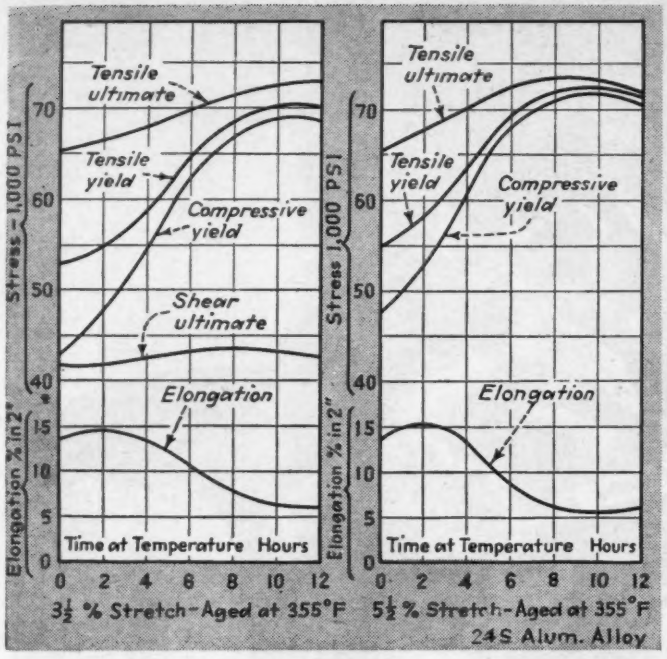

Fig. 20

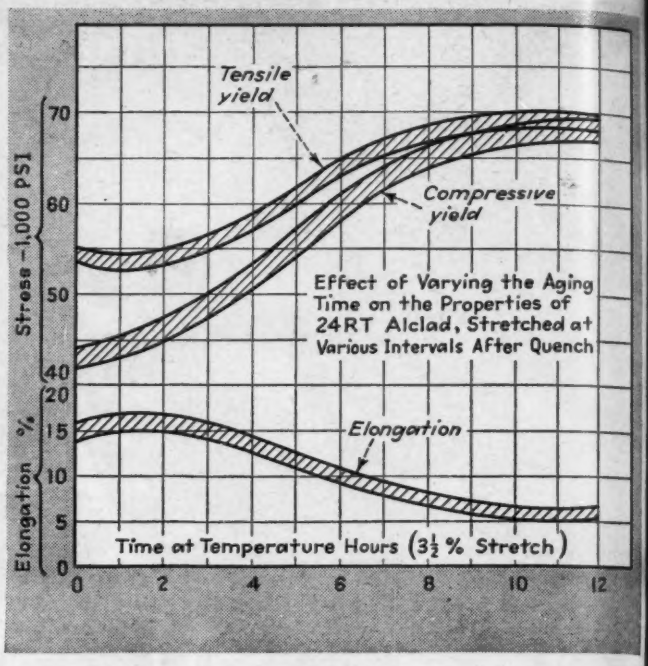
Tensile yield
Compressive yield
Effect of Varying the Aging Time on the Properties of 24RT Alclad, Stretched at Various Intervals After Quench
Elongation
Stress—1,000 PSI
Elongation %
Time at Temperature Hours (3½ % Stretch)

Fig. 21

the stretching operation for the production of 24RT Alclad and 24ST8R3.5 Alclad. In order to maintain quality control of the finished product, therefore, the stretch under load should be about 4.0 + .5 percent
— 0 percent
discounting any slippage that might occur in the stretching jaws.

In the aging operation for producing the "T8" tempers, aging temperature and aging time should be controlled as closely as possible to the conditions specified. Standardization of the aging procedure to a temperature of 365 deg. F. for a period of 7 to 10 hr. will do much to make both test results and aged material interchangeable throughout the aircraft industry. Within each plant, however, proper precautions should be taken to see that the center portions of large loads of 24S material are up to temperature before the actual temperature cycle begins. Maximum thickness of obtainable Alclad sheet is sufficiently thin that the mass effect on any individual piece of material is unimportant. Adequate space and ventilation between sheets or assemblies in the aging oven, for the circulation of the heating medium, does much to maintain uniformity in the material properties.

Ordinarily, the processing of aged parts should be identical with currently accepted methods for the manufacture of aluminum alloy parts, with the addition of the aging cycle as one of the final operations. Should the production process necessitate severe forming or joggling of 24S parts that are already in the aged condition, the material should be heated to 365 deg. F. ± 5 deg. F. and formed while hot (365 deg. F. to 300 deg. F.) thereby causing little change in the mechanical properties.

Inspection Control

Benefits to be derived from these "super-aluminum" alloys would not warrant their use if inspection control were difficult in selecting the aged from the unaged stock. This problem is now being investigated by the CVAC test laboratories, and test data so far obtained indicate that sufficient spread appears to exist in the Rockwell hardness readings on aged 24S sheet to differentiate it from "soft" and 24ST material.

Considerable differences appear to exist between the inspection methods used at various aircraft factories to determine the hardness and corresponding tensile properties of such common metals as 24ST and 24ST Alclad. Fig. 22 gives the Rockwell "E" hardness vs. strength relationship for 24ST and 24ST Alclad sheet. The dotted 24ST curve is usable on all sheet gages above 0.020 in. This curve closely approximates the 0.020–0.064 in. 10 percent Alclad curves in the working range between 50,000 and 70,000 psi.

The Rockwell "E" scale (⅛ in.-dia. steel ball and 100 kg. weight) was used in this CVAC investigation to measure all hardness values because this scale spans the entire range for 24S aluminum alloy, from the SO to the ST condition. In many factories, the "B" scale is used for ST material; but since the "B" scale cannot be used for "soft" aluminum, another scale has to be used for the SO and "Alclad" conditions.

In general, the Rockwell "E" hardness is increased from six to eight points by the aging process. To date, the gunshot patterns obtained in the CVAC test, formed by plotting hardness vs. tension ultimate, tension yield, and compression yield, have not indicated the correlating factor in aged Alclad materials. Since hardness readings are relative and form only a rough guide for determining whether the parts have been heat treated, stretched, and/or aged, the information given in Fig. 22 (increased by six to eight "E" points for aged material) is probably sufficiently accurate for shop use until the new test data are available.

Superior Rivets for Tomorrow's Planes

Nothing has heretofore been said about the joints or means of joining the "super-aluminum" alloys just discussed. Today, it is common practice to use a 2½ percent copper and 0.3 percent magnesium alloy, called "A17S", for small rivets; that is, up to ¼ in. dia. Rivets of ¼ in. dia. and over usually are made from 17ST (4.0 percent copper, 0.5 percent manganese, 0.5 percent magnesium), or 24ST (4.5 percent copper, 0.6 percent magnesium, 1.5 percent magnesium) because of the need for the additional mechanical properties in the joints necessitating such large rivets. Rivets of A17ST alloy are most widely used and popular in aircraft manufacture, since they may be driven in the fully heat-treated and aged condition without resorting to refrigerated storage.

Both 17ST and 24ST rivets, after heat treating, must be chilled quickly and maintained at low temperatures to delay the hardening process. The 17ST rivets may be kept sufficiently soft to drive after 24 hr., if stored at the temperature of melting ice (+32 deg. F.), or they may be kept "dead soft" indefinitely at storage temperatures of −10 deg. F. The 17ST rivets maintain satisfactory driving characteristics at room temperature (+70 deg. F.) for

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No other American-built fighters have fought so many battles, have downed so many enemy planes—over mountain, jungle, desert and sea—from the bleak Arctic to the blistering tropics—as have the Curtiss pursuits, veterans of the battleskies of World War II.

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To help bring them safely home, we're giving them the best equipment we can produce. The finest of food, clothing, medicine, guns, tanks, planes.

That's why planes like the U. S. Army Bell Airacobra are designed with stout armorplate protecting the pilot . . .

With self sealing gas tanks . . .

With bullet-resistant "armor glass" . . .

With a 37 mm. cannon in the nose. (After all, an explosive cannon shell hurtling at the enemy is a pretty good protective device!)

These and all the other safety features built into American planes add weight, make design problems tougher. But they'll bring safely home many an American boy who might not have come home without them.

WHEN they come home, they'll want planes of peace. There'll be another era of aircraft pioneering—this time to make planes still safer, simpler, more useful, more economical. You'll see then how an aircraft manufacturer could pack decades of aviation progress into a few short years of war. © Bell Aircraft Corporation, Buffalo and Niagara Falls, New York.

BELL Aircraft

AIRACOBRAS for victory—future planes for peace

about 1 hr. Rivets driven after they have hardened for more than an hour may develop radial head cracks upon forming. The 24ST rivets are still more temperamental about their surrounding temperatures, necessitating use of the −110 deg. F. chill of dry ice (CO_2) for long-term storage. Rivets of 24S material are not a practical production item, even though extensively used by several factories, since they must be driven within 10 min. after removal from the dry ice box. Therefore 24S rivets require frequent reheat treatments on the production line.

Fig. 23 shows the properties of a "superior" rivet of 17ST which may find considerable use in joining sheets and formed sections of "super-aluminum" alloys in the *Altiliner* of 1945. Flat-headed 3/32 in. dia. rivets were formed in a rivet manufacturing machine at CVAC from single lengths each of 17SO and A17SO wire. All rivet samples were subjected to a standard heat treatment of 950 deg. F. for 50 min., then quenched in 50 deg. F. water. The rivets were driven, at various time intervals after removal from the salt heat-treat tanks, into conventional single-rivet, double-shear test specimens made from 0.064 and 0.128 in. 24ST Alclad sheets.

Since it was found that the diameter of the driven rivets at the shear plane varied considerably due to the expansion of the rivet shank to the hole size, each hole was carefully measured with a micrometer and a tapered pin, and the corresponding shear area was used to obtain the plotted shear stresses. Photomicrographs made at the shear plane on several rivet shanks indicated that no appreciable difference existed in the metallographic structure at the shear plane of driven and undriven rivets.

The photomicrographs also indicated a greater precipitation in quantity and particle size of the hardening constituent ($CuAl_2$) in both the 17ST and A17ST rivets, due to aging. The two lower curves of Fig. 23 concern A17ST rivets. The bottom curve gives the 28,500 psi. shear stress developed after five days, and the one above gives a shear stress of 32,500 psi. five days after driving, in which the rivets were permitted to age-harden four days prior to installation. The ANC-5 minimum allowable shear ultimate for an A17ST rivet is 27,000 psi. It is therefore essential that provision be made for efficient joint design by allowing three to four days to elapse between heat treatment and installation, to gain the higher strength.

The upper two curves of Fig. 23 apply to 17ST rivets. The curve second from the top is typical of the 36,000–37,000 psi. shear ultimate obtainable by driving the rivets within the conventional 30-min. period after removal from the refrigerator, while the top curve illustrates the 41,000–42,000 psi. shear ultimate obtainable by driving the 17ST rivets after three days' aging at room temperature.

To be sure, the higher shear properties of aged and driven 17ST rivets must be purchased at a price—that of radial cracks in the rivet heads. This, however, is not serious from the strength standpoint, since many such cracked rivet heads have been tested at CVAC and the tension and shear strength of the rivet joint has been found to be only negligibly affected. Cracked rivet heads may, however, present a corrosion problem unless primer and paint can be made to penetrate and seal the fissures.

The Aluminum Co. of America, on page 37 of its 1941 bulletin *Aluminum in Aircraft*, states:

"Cracking at the edge of the head frequently results from overdriving, or from driving rivets that have undergone too much age hardening. However, it has been determined that even badly cracked heads are strong enough to develop the full shear and tensile strength of the shank. A series of rivet heads was tested in tension to determine how well formed a head had to be in order to develop full strength. The tensile strengths of all of the rivets were within 5 percent of the strongest one. The foregoing is presented for the purpose of indicating that superficial cracks in rivet heads and minor deviations from the theoretically desired shape of head are not cause for concern or replacement."

Some research work must be done to determine the effect of vibration and cyclic loading on the cracked 17ST rivet heads. It may be that an inspection standard can be developed, based upon a mass of empirical data, as "go" and "no-go" criteria for use on the production line.

Recent CVAC tests upon the effect of elevated-temperature aging on A17ST and 17ST rivets indicated that:

1. Aging of driven 17ST rivets at 350 deg. F. ± 2 deg. F. for 7½ hr. increases their shear strength approximately 5 percent.
2. Aging of driven A17ST rivets under the same conditions does not appreciably affect shear strength.

Rivet specimens submitted to the above tests were of 7/32 in. dia. and were

(*Turn to page* 302)

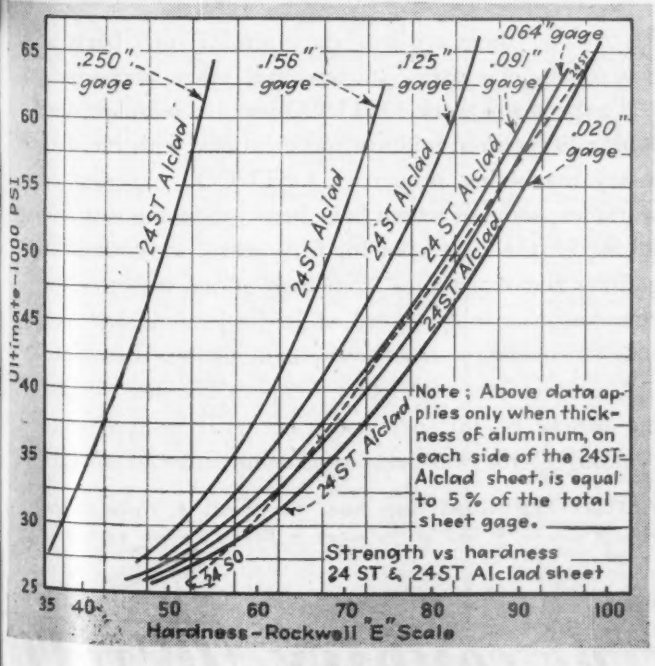

.250" gage
.156" gage
.125" gage
.064" gage
.091" gage
.020" gage
24ST Alclad
Note; Above data applies only when thickness of aluminum, on each side of the 24ST-Alclad sheet, is equal to 5% of the total sheet gage.
Strength vs hardness
24 ST & 24ST Alclad sheet
Ultimate-1000 PSI
Hardness-Rockwell "E" Scale

Fig. 22

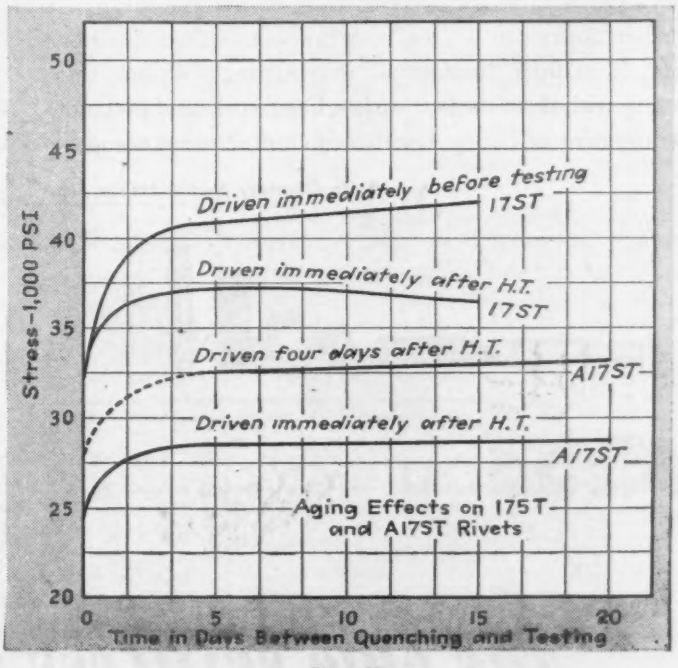


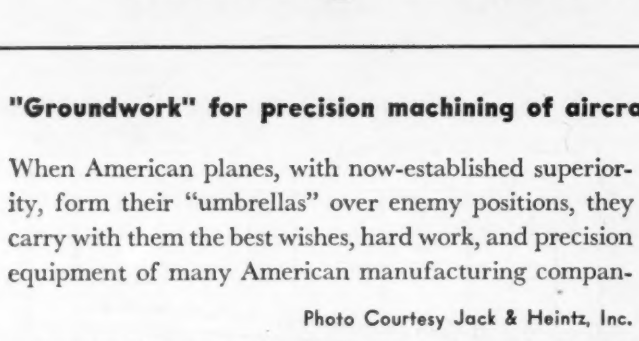
Fig. 23

Ceiling ZERO? Not any more!

"Groundwork" for precision machining of aircraft parts laid by OSTUCO

When American planes, with now-established superiority, form their "umbrellas" over enemy positions, they carry with them the best wishes, hard work, and precision equipment of many American manufacturing companies. Among these are manufacturers of such parts as generators, energizers, starters and other accessories.

Photo Courtesy Jack & Heintz, Inc.



To speed this work, OSTUCO supplies seamless steel tubing to required military specifications, with the necessary machining properties. OSTUCO's experienced workmen, some of whom have been producing seamless tubing on the same spot for fifty years, are constantly gaining new experience from their efforts to better the company's enviable record of low rejections and "on time" deliveries — from ever-changing war demands.

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RECONVERSION RESERVES

They're Postwar Worry No. 1

By RAYMOND L. HOADLEY
Financial Editor, "Aviation"

Ask the aircraft manufacturer to name his No. 1 postwar worry and the odds are he will promptly reply "Cash for the payrolls and seed money to finance peacetime production."

He knows that his industry must be allowed to accumulate adequate reconversion reserves or else government money must do the job. Otherwise, this young giant of mass production that has come up from the sphere of the handicrafts may be considered as on the way out—consigned, as it were, to a postwar desert.

The government has made it very easy for the aircraft companies to get into the war up to their necks, but it has made no provision to get them out. Thus the next major issue on the home front for Congress to settle concerns reconversion reserves. How well the warplane makers are able to meet the transition from war to peace probably will be decided in the next two or three months.

No wonder the industry feels that Congress and the procurement agencies have overlooked its needs for financial stability. Here, if ever, is a case for special pleading, since aircraft's position is entirely different from that of the makers of consumer goods who left their chosen fields for war production. The latter will return to their regular business and enjoy huge backlogs of unsatisfied civilian demand for their products.

Take the automobile industry for example (and what is said of this industry is almost equally true of the tire makers, silversmiths, radio producers, etc.): Analysts forecast a demand for 25,000,000 new passenger cars in the first five years after the war ends—probably 6,000,000 cars in each of the first two years. In contrast, the aircraft industry, which will produce nearly 100,000 planes in 1943, can look forward to a normal peacetime output of 6,000 private craft and 500 transport planes, according to estimates of the Aeronautical Chamber of Commerce.

But the point is that aircraft, tank, and ordnance work is just a stop-gap for the motor car concerns. And they are making fairly reasonable—although not excessive—profits while the demand piles up on their "bread and butter" products. They seem to have no particular fault to find with contract renegotiation and have not been very exercised over contract termination.

The reason for this apathy is not hard to find. This veteran industry entered the war well-heeled financially. And from the end of 1941 to Mar. 1943, General Motors Corp., to cite the largest company, has established postwar contingency and rehabilitation reserves of $48,000,000. Its total postwar reserve cushion for reconversion amounts to almost $78,000,000, and it is still going up. Chrysler Corp. is setting aside $3,000,000 each month for postwar reconversion besides other smaller but similar reserves.

At the same time, 16 leading aircraft concerns, in contrast, had postwar reserves of $36,131,000 at the 1942 year-end plus $18,000,000 in postwar credits. Their taxes are too high to permit any such reserves as those of the seasoned industries which are filling in on war work, although the aviation industry's need is certainly as great.

It is the great misfortune of the plane makers that it was their very low earnings in the prewar years which were used as a tax base. Thus it is that normal earnings for the aircrafts are set at much lower relative levels than those of many other industries. One could almost say that most of the aircraft concerns were hit by the excess profits tax as soon as they showed any earnings at all. Furthermore government renegotiation officials have strongly intimated that profits on Army contracts may be lower this year.

Nor have aircraft profits been too freely distributed to stockholders. Consolidated Vultee, for instance, with $9,000,000 in earnings last year, paid out $1,300,000 in dividends. Douglas Aircraft paid out *50* times as much in wages as it did in dividends to the owners of the company.

Labor can, as it is doing, lay aside its excess war earnings in government bonds. But government not only siphons off industry's excess profits, as it should do, but even takes away the reserves that should be established to reconvert plants and insure the maximum that is considered a postwar must. Management has failed thus far to make any impressive case for its own big stake in industry's postwar reserves. If labor realized that adequate reserves mean more postwar jobs at better wages, management would have a strong political ally at its side when it faces Congress on the matter of reserves.

Stuart Chase, who is not without influence in New Deal circles, suggested recently that a severance pay of six months be made to war workers. That would cost Consolidated Vultee about $125,000,000. And as Francis A. Callery, vice-president of Consolidated Vultee, recently pointed out to a Congressional committee, his company's 1942 earnings were equal to about two weeks' pay. It would take twelve years to make up the rest of the six months' severance wages.

Postwar reserves are necessary not only to keep production employees on the payrolls but also to design and produce new peacetime aircraft. One company estimates it costs around $4,000,000 to build the prototype of a large passenger plane and that the tooling necessary for quantity production would cost an additional $10,000,000.

The fact is that many farsighted industrial executives now believe that prices after the war may be as much as 50 to 60 percent higher. Consequently they feel they will need more money than during the last decade to buy materials, pay labor, carry inventories, and meet other expenses. These executives now plan to lay aside even larger cash reserves than heretofore to meet future working capital needs.

It is true that the Truman committee recently urged the allowance of somewhat larger profits by renegotiation agencies to permit the creation of reconversion reserves. But the service departments solidly oppose any such change in renegotiation policy.

Under Secretary of the Navy Forrestal, for example, feels that the question of allowing a portion of profits for reserves is "too broad" a question to be handled in renegotiation alone. There was much talk last spring that Congress planned to modify the renegotiation law. But the only action Congress has taken to date was to tighten the law by quietly bringing defense plant contracts

(*Turn to page* 295)

It Would Be a Smart Move

says the author, if aircraft and other industries in the same boat united on a program and presented it to Congress. Meantime, he offers this vital advice for companies seeking postwar financial stability:

Keep your finances as liquid as possible—particularly your reserves.

Plan your operations so you won't be caught with excessive inventories in a critical period when raw material prices are tobogganing.

Develop a capital expenditure budget and an operating budget for the reconversion period—which may come sooner than you think.

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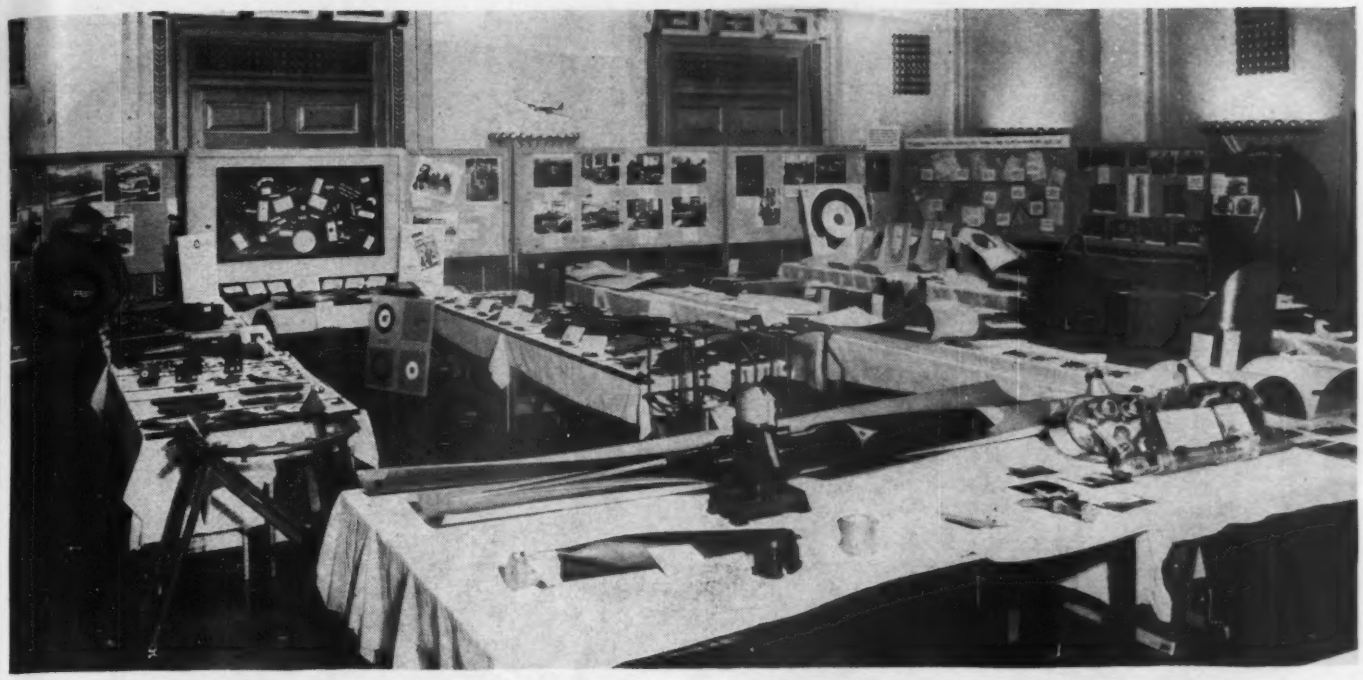

Under sponsorship of Dominion government, exhibits in Toronto and Montreal contrast old and new methods, revealing to executives, engineers, and workers the various measures taken to save materials, time, labor, and money. Processes and techniques covered in Toronto display (seen here) represent conservation of more than 900,000 lb. of materials, 3,400,000 man-hours, and $4,244,703. Some nine companies cooperated by providing displays in the exposition.

Conservation in Canada's Aircraft Industry

By JAMES MONTAGNES

"Aviation's" Canadian Correspondent

Constantly tracking down "the better way," Dominion aviation companies have effected prime savings in materials, man-hours, and money . . . . Special exhibits apprise plant men of new methods.

To aid the continuous search for better methods of production and the conservation of labor, time, and materials, the Canadian government's wartime Department of Munitions & Supply has held special exhibits in Toronto and Montreal showing results of conservation measures taken by various manufacturers. To these exhibits were invited not only the factory executives and engineers but also every war worker.

By seeing what the other factory is doing to save materials and to develop new production processes and methods saving time, labor, and money, visitors to this exposition obtained ideas which can be adapted in their particular plants and are encouraged to develop new conservation measures. The exhibit likewise informed the war worker and the executive of the practical results of the suggestion box technique.

A considerable section of the conservation exhibit was given over to the aircraft industry and what it has accomplished—in labor and time saving processes, in the substitution of critical materials by new materials, and in the saving of weight in the final assembly of aircraft. Savings have been accomplished in big items as well as small. The exhibits were so arranged that each product was shown in its old form and in its new form, with a card showing exactly what the item is for, what it was formerly made of and how processed, and what annual savings in time, material, machine tools, and dollars resulted from the new process and new material. The whole story is there to see.

Among the firms taking part in the displays were Boeing, Canadian Car & Foundry, Canadian Vickers, Canadian Westinghouse, deHavilland, Fairchild Aircraft, Fleet Aircraft, Noorduyn Aviation, and Ottawa Car & Aircraft.

One example of savings effected is found in the small item of identification labels. Formerly these were engraved wherever necessary on the aircraft, requiring cellulose and acetate sheet and engraving equipment. Today, on all aircraft and on all equipment going into Canadian aircraft, decalcomania transfers are affixed where engraved labels were formerly used. On the Bristol-designed *Bolingbroke* bomber, Fairchild Aircraft, Ltd., estimates that this new method saves 3,250 lb. of the original material and 20,000 hr. of labor in a year.

Similarly, there is the item of aircraft insignia of the Royal Canadian Air Force, a large circle in red, white and blue. Formerly these markings were applied by a spray-paint process, requiring careful hand work in the affixing of rubber content masking tape. Now decalcomania transfers are used.

Identification tags were formerly made of brass, punched and stamped. Now adhesive tape is used, saving 2,500 lb. of brass sheet each year on the *Bolingbroke* alone. Moreover, need for a punch press and stamping machinery has thus been obviated.

Furthermore, the micro-switch housing on the *Bolingbroke* used to be made of built-up steel, sheet welded, and with ball bearings and machined parts. There has now been substituted an aluminum alloy casting with oilite bushing, saving 600 lb. of sheet steel, 600 ball bearings, and 10,000 hr. of labor. Thus one mill-

(*Turn to page* 285)

More powerful, smoother running airplane engines are already in testing chambers where data provided by modern equipment will quickly ground them or give them their wings. Others are on drawing boards ready for production. However revolutionary tomorrow's engines may be, Jacobson will be prepared to provide test stands and equipment for their testing and maintenance.

Jacobson engineers, working closely with engine manufacturers and technicians of the Army and Navy Air Forces, are *anticipating* tomorrow's needs in the development and construction of today's engine test equipment. This advance planning is an important part of Jacobson's service in the design, engineering, manufacture, and installation of engine test equipment.

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Wanted:
A Haven for Aviation Securities

By H. L. FEDERMAN

Analysis of investment trust holdings shows both transport and manufacturing stocks dropped from trust portfolios, mirroring public apathy.

AVIATION securities are no longer in wide popular demand. At least this is the impression gained by examining the portfolios of the nation's leading investment trusts.

Generally, investment trusts mirror the popular taste or distaste for specific securities. More important, though, this group as a whole controls huge reservoirs of capital which can be of material aid to industry.

It is astounding to observe the insignificance—and in many instances the complete lack—of aviation securities among investment trust funds. Table I shows the aggregate aviation holdings of 20 major general investment trusts reporting as of June 30, 1943.

Before examining this material, however, certain qualifications should be noted. For one thing, there is no assurance that changes have not been made since June 30. In view of market conditions, a tabulation as of today might easily show a different picture. General investment trusts are also known to have stipulated policies which prescribe the extent of commitments they may make in any one industry. Further, investment fund managers are not infallible in judging market trends and individual issues. Recognizing these limitations, an appraisal of the investment trust viewpoint toward aviation equities can be safely advanced.

Aviation securities never were particularly popular with investment trusts. This has been true because the tendency has been for these funds to look to the more conservative industries for commitments. Neither the air transports or the aircrafts have yet been able to assume the stature of stable, mature industrial developments. Nevertheless, as soon as both aviation groups began to record spectacular progress, small participations were made in their securities by various funds.

It is probable that the height of investment fund participation in all classes of aviation securities was reached during the second half of 1941. Since that time there has been a consistent trend towards liquidation, with the result that at the most recent date available—June 30, 1943—trust fund investments in aviation equities are at their lowest point since they gained popular favor.

A number of the country's largest and better managed funds do not now own a single share of any aviation company. For example, State Street Investment, with total assets of about $47,500,000, is without an aviation commitment in its portfolio, yet in the past it has had material investments in this group. Ironically, the Chemical Fund, a trust originally created to invest in "growth" type industries, is also completely lacking in aviation securities. Selected Industries and Tri-Continental Investors (both under the same management), with combined resources of $70,000,000, owned no aircraft manufacturing shares and but small participations in airline equities. Many other trusts examined were completely devoid of aircraft issues with but minor interests in air transports. Even the latter group showed indications of being in the process of liquidation.

Prevailing investments in aviation issues as of June 30 permit a number of observations. By any measure, air transport equities are far more popular than the aircrafts. In general, there is a strong tendency to favor the larger and better entrenched companies in the field.

Among the air transports, Pan American is clearly the favorite. Moreover, these commitments in this issue have actually been increased by the trusts in recent years—a notable exception to the general rule. For example, with more reports available at the time, AVIATION for Mar. 1942 showed that among 40 trusts examined, 12 owned a total of 109,900 shares of Pan American as of Dec. 31, 1941. As of June 30, 1943, 12 out of the 20 trusts examined held 176,200 shares of the same company. Significantly, in the interim, Massachusetts Investors increased its holdings from 16,000 to 45,000 shares.

The exploits of Pan American and its bid for post war aerial trade routes—as a result of past experience—makes it a favorite for great expectations among fund managers. It is the future of this international air carrier that is being anticipated. It is a fair surmise, however, that should the company come to appear to be in jeopardy of losing its monopoly over certain routes, investors will take another look at the position of the carrier.

Among the domestic carriers, United Air Lines and American Airlines received the bulk of interest accorded the Group. These transcontinentals, because of their strategic position, promise to be in the forefront of air trans-portation's future development, and they have meanwhile established a record of stability in earnings.

Absent from all trust fund lists examined were the shares of TWA, the remaining transcontinental line. This is undoubtedly due to the fact that its earning record has been somewhat erratic, a word from which trust managers shrink. It should be noted, however, that this stock was never prominent in investment trust portfolio. Interestingly enough, the Hughes Tool Co.—headed by Howard Hughes—which owns about 45 percent of TWA's outstanding stock, has not appeared as a purchaser for almost a year. This may carry any number of implications. It is possible that the Hughes interests may have acquired all the TWA stock they deem desirable. More likely, however, the Hughes people may have no desire to compete with the public in bidding up the price of TWA in the market. It will be recalled that in periods of market weakness, the Hughes interests

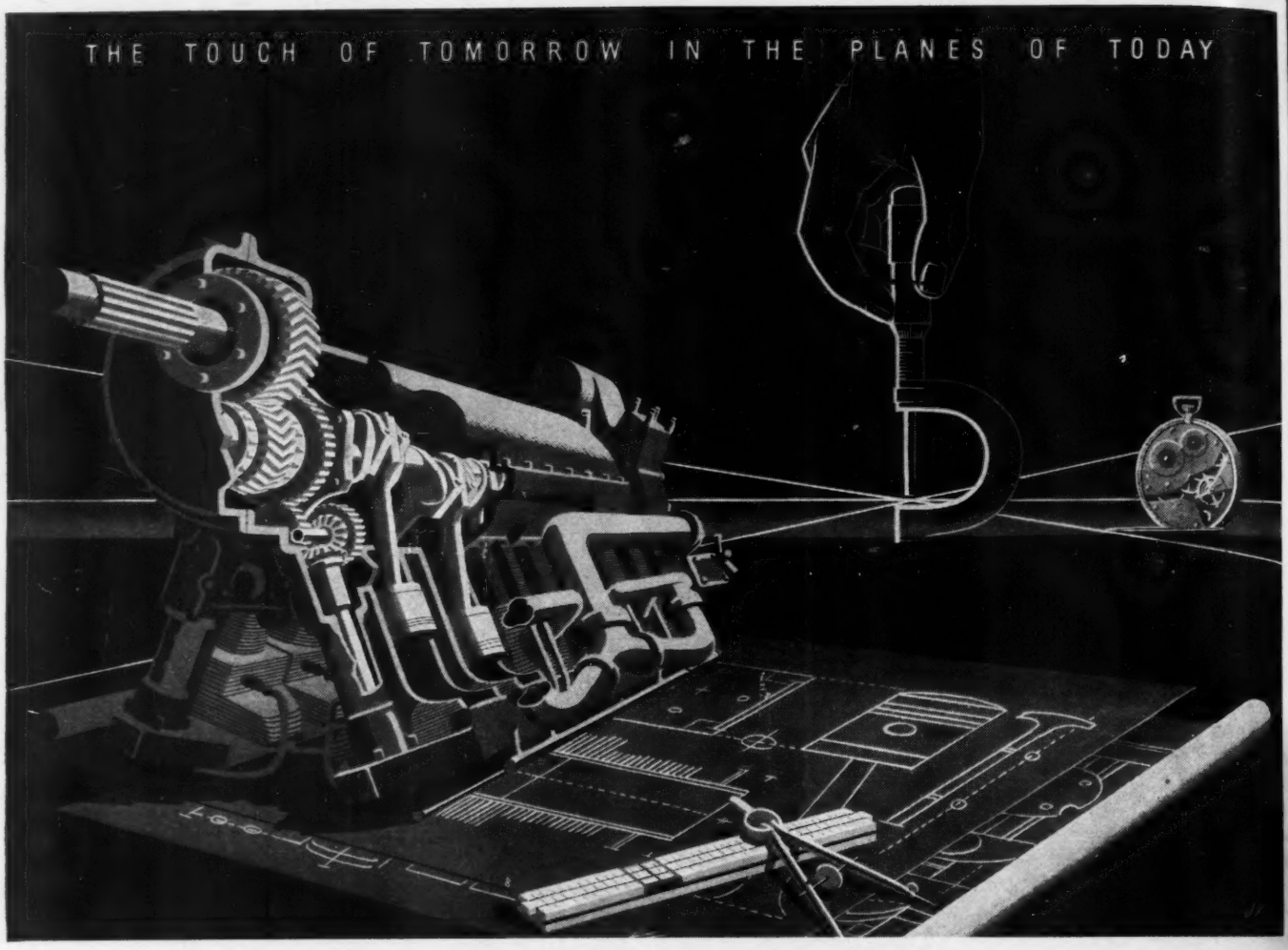
(*Turn to page* 305)

TABLE I.
COMBINED AVIATION HOLDINGS
20 Major General Investment Trusts as of June 30, 1943

	No. Trusts Holding	Total Shares Held
Air Transports		
American	7	20,100
Eastern	5	17,100
Northwest	1	16,000
Pan American	12	176,200
Penn-Central	2	3,400
United Airlines	7	71,100
Aircraft Manufacturers		
Curtiss-Wright "A"	2	42,700
Douglas	1	2,000
Lockheed	2	2,000
Martin	2	2,000
North American	1	24,000
Sperry	2	17,500
United Aircraft	3	19,500

TABLE II.
BARRON'S STOCK AVERAGES

	Aircraft	Air Transport	50 Stocks
July 29, 1943	30.35	38.94	80
July 22, 1943	31.68	40.94	84
July 15, 1943	32.32	41.72	85
July 8, 1943	33.32	43.59	83
July 31, 1942	27.90	19.34	59



How Precise is Precision?

Maybe *your* yardstick is a fine watch. *Ours* is a Ranger 12-cylinder in-line, air-cooled engine. See the comparisons between the two listed below.

A whole battery of fine laboratory instruments, plus the genius of craftsmanship, are responsible for the Ranger's outstanding precision performance.

There's the spectroscope, for example—so sensitive it can spot a particle of metal as minute as seven parts in a hundred thousand. Fairchild uses it to explore and to control the metals in Ranger engines.

A quarter million volt X-Ray is another Fairchild key to secrets that are hidden beneath 4 inches of solid steel. It tells our engineers which metals can "take it."

Under a metallurgical microscope our technicians can read the history of any metal . . . tell how it was processed during manufacture.

With electrical instruments they can detect a flaw one ten-thousandth of an inch in depth that *could* become a bottomless pit of danger.

A beam of black light is played over machined surfaces to expose the structural "criminals" that may lurk within.

These and hundreds of other present-day miracles are routine matters for Ranger engineers and scientists. Result—the Ranger Engine...combination of precision and power . . . another Fairchild "touch of tomorrow in the planes of today."

A QUALITY WATCH	A RANGER ENGINE
PARTS—about 350.	PARTS—exactly 4,127
PRECISION measurements—wheel pivot held to a tolerance of 1/2 of 1 per cent of its diameter.	PRECISION measurements—impeller shaft held to a tolerance of 1/10 of 1 per cent of its diameter.
SPEED of moving parts—balance wheel oscillates 5 times per second.	SPEED of moving parts—fastest part revolves 520 times per second.

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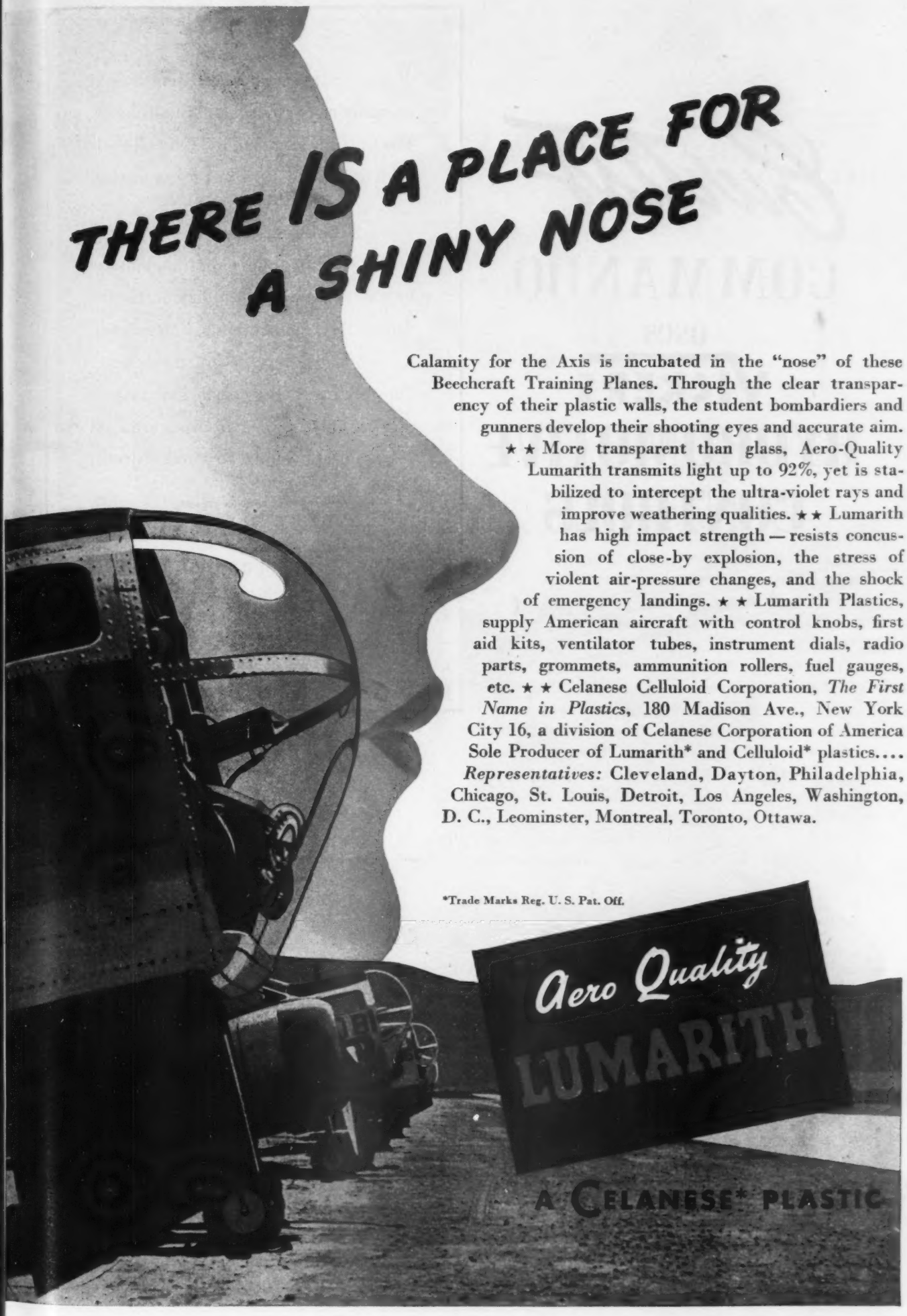
RANGER AIRCRAFT ENGINES

Division of Fairchild Engine and Airplane Corporation • Farmingdale, Long Island

THERE IS A PLACE FOR A SHINY NOSE



Calamity for the Axis is incubated in the "nose" of these Beechcraft Training Planes. Through the clear transparency of their plastic walls, the student bombardiers and gunners develop their shooting eyes and accurate aim. ★ ★ More transparent than glass, Aero-Quality Lumarith transmits light up to 92%, yet is stabilized to intercept the ultra-violet rays and improve weathering qualities. ★ ★ Lumarith has high impact strength — resists concussion of close-by explosion, the stress of violent air-pressure changes, and the shock of emergency landings. ★ ★ Lumarith Plastics, supply American aircraft with control knobs, first aid kits, ventilator tubes, instrument dials, radio parts, grommets, ammunition rollers, fuel gauges, etc. ★ ★ Celanese Celluloid Corporation, *The First Name in Plastics*, 180 Madison Ave., New York City 16, a division of Celanese Corporation of America Sole Producer of Lumarith* and Celluloid* plastics.... *Representatives:* Cleveland, Dayton, Philadelphia, Chicago, St. Louis, Detroit, Los Angeles, Washington, D. C., Leominster, Montreal, Toronto, Ottawa.

*Trade Marks Reg. U. S. Pat. Off.

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VICKERS Hydraulic Equipment is used on many of the most modern airplanes. The Curtiss "Commando" Cargo-Transport illustrated here is representative.

Vickers Hydraulic Controls are high pressure oil hydraulic controls that are so widely used because they do the job dependably, smoothly and accurately . . . no matter how severe the service. They are insensitive to shock and vibration yet light in weight . . . easy to adjust . . . admirably suited to aircraft needs.

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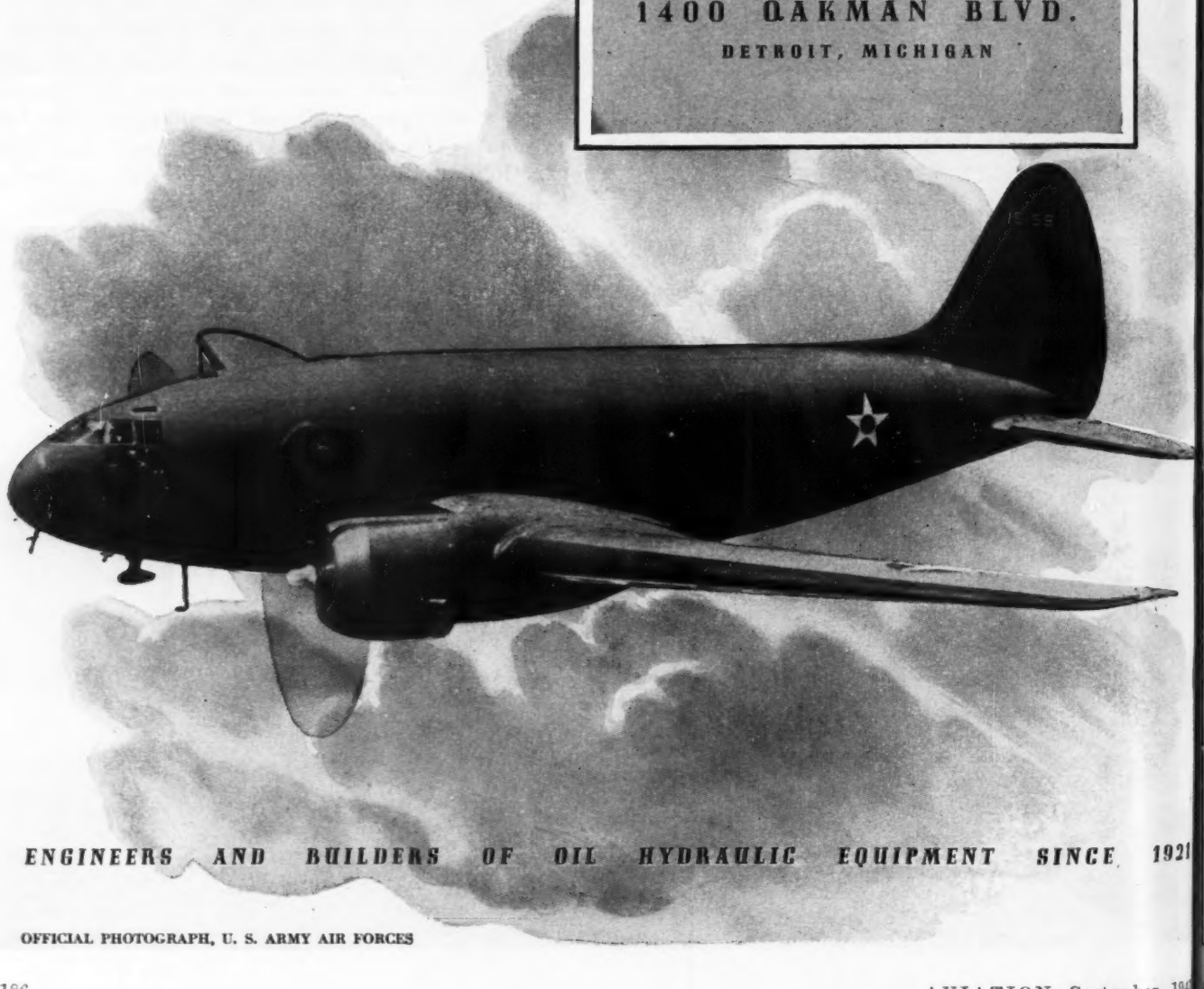
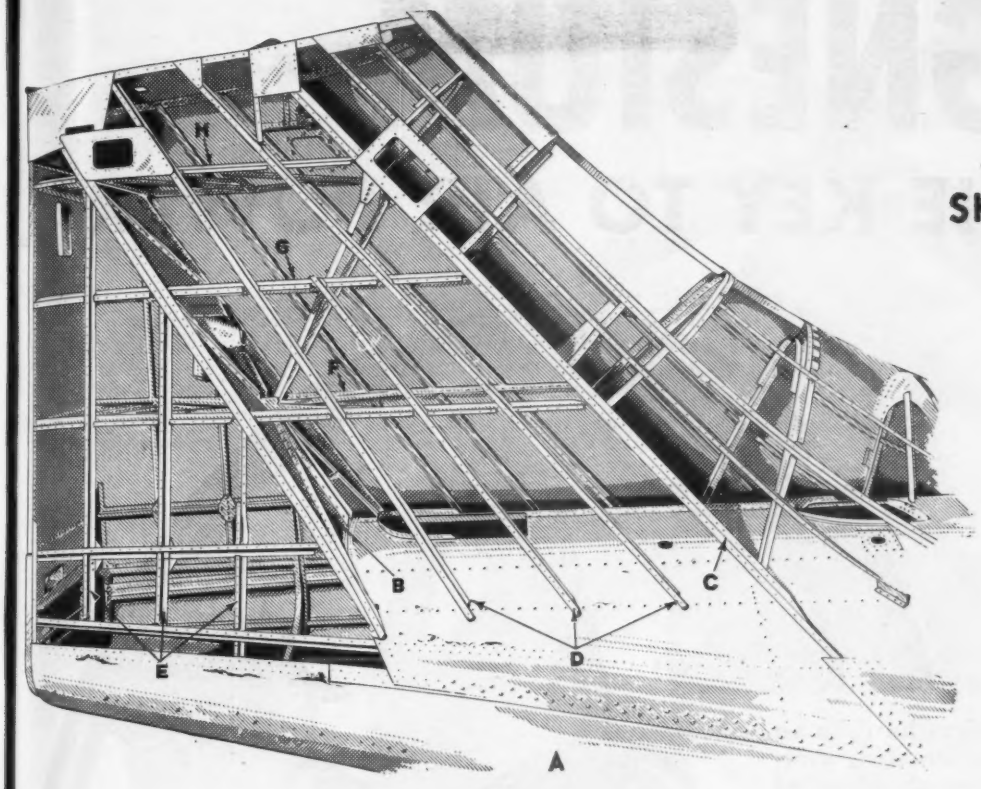


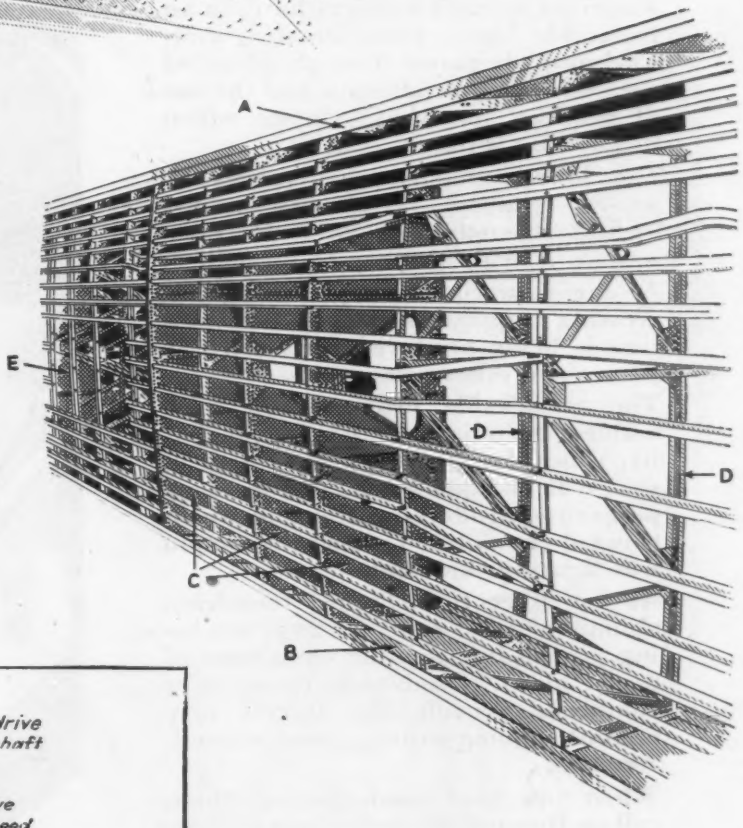
ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

OFFICIAL PHOTOGRAPH, U. S. ARMY AIR FORCES

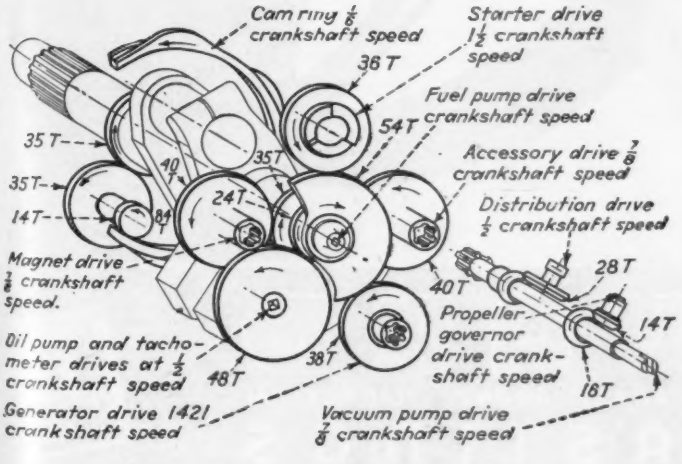
SKETCH BOOK OF DESIGN DETAIL



Lower portion of vertical stabilizer of Consolidated Vultee PBY *Catalina* attachment to fuselage *A* (above) employs use of two banjo-type bulkheads *B* and *C*, together with diagonal and vertical channel stringers *D* and *E*, respectively. Lateral stresses are taken up by truss-type members *F*, *G*, and *H*.



Wing structure of Consolidated Vultee PBY *Catalina* (right) with front spar at *A* and rear spar at *B*, shows three types of bulkheads employed: Built-up web type *C*, which provides support for wing strut loads; truss type *D*, used in remainder of wing; and solid fuel-tight web type at *E*. Bulkhead *E* is outboard end of integral fuel tank of which spars form fore and aft walls. (Also see AVIATION'S August Sketch Book.)



Schematic diagram of gear train of Jacobs L-4MBB seven-cylinder radial aircooled engine which delivers 225 hp. at 2,000 rpm.

MAGNESIUM—
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American aircraft builders have, in an incredibly short time, created overwhelming air power through advanced design, flo-line production and the use of modern materials, among which magnesium is paramount.

The lowest of structural metals in specific gravity, yet possessing the highest strength-to-weight ratio, magnesium is truly the key to air power.

At the Howard foundry, an ever-increasing tonnage of magnesium castings is being produced for America's planes and other armaments.

The remarkable properties of magnesium, including its easy machinability, which are proving their worth in war, will be equally valuable in many peace-time products, a trend in which Howard Foundry Company's output will figure prominently.

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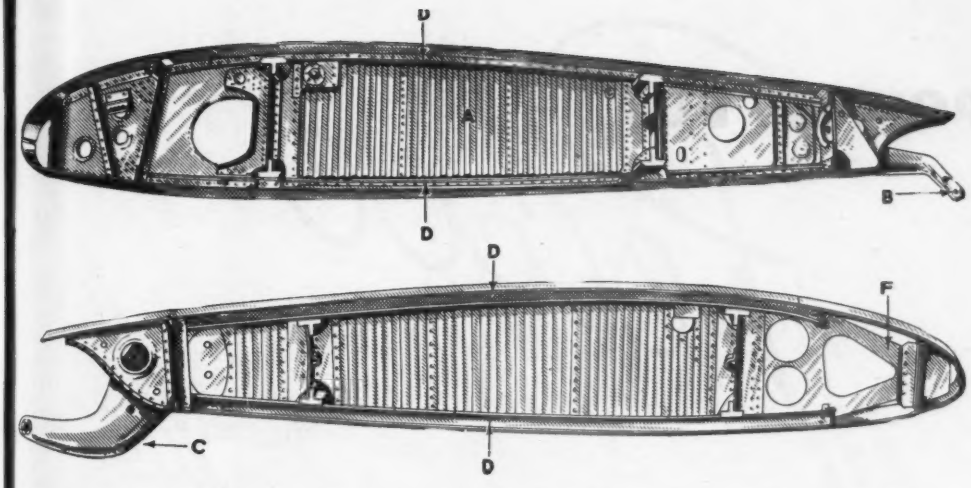
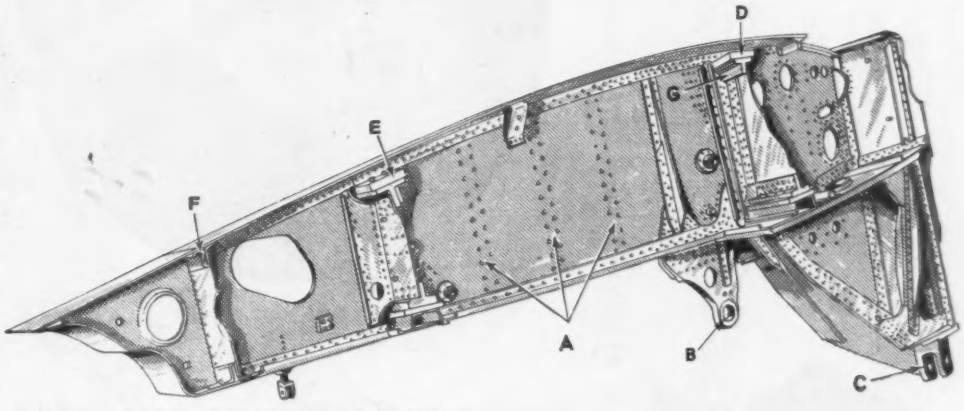
CASTINGS

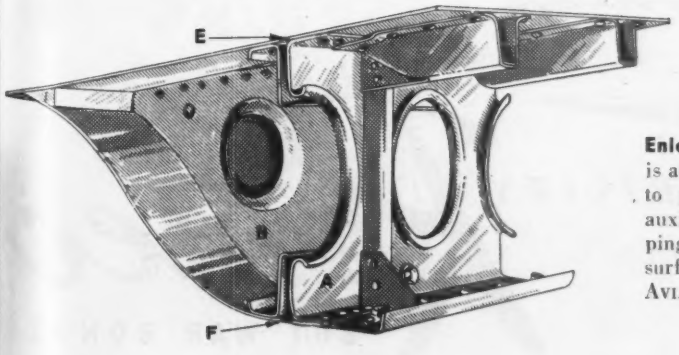


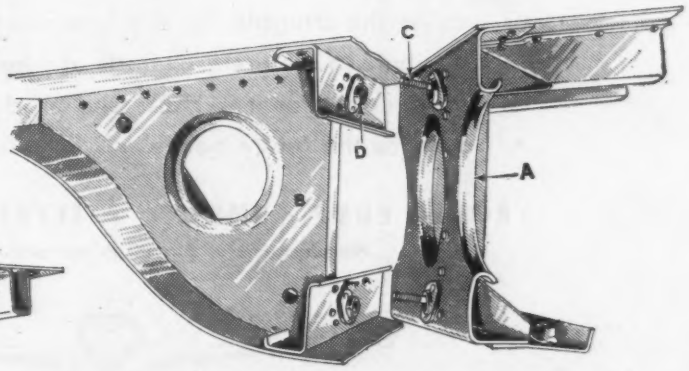
SKETCH BOOK OF DESIGN DETAIL

Shown above are two ribs of Ju-88 located between cutouts in bottom of wing. Both are constructed with reinforced corrugated aluminum alloy *A*, instead of stiffeners used in engine-mount ribs. Flap control arm is shown at *B* in top sketch and aileron control at *C* in lower sketch. Both top and bottom edges of each of these ribs are reinforced with angle sections riveted along contours at *D*. Leading edge is small D-section through which heated air is passed for anti-icing. This air is taken in behind radiator, then passed over exhaust manifold and piped throughout length of leading edge. Being discharged into interior of wing, heated air raises temperature of entire surface to prevent ice forming. Note support construction at *F* to hold leading edge D-spar.

Wings of Junkers Ju-88 have six ribs, two of which are located at engine mount, as shown in this sketch of inboard engine nacelle rib. These ribs are strengthened by stiffeners on reverse side at *A*, this being major construction difference from other ribs. Landing gear hinge points are located at *B* and *C*. Front spar is at *D*, rear spar at *E*, and auxiliary spar at *F*. Front and rear spars are constructed of two T-channel sections *G* and *H*, riveted to a piece of flat aluminum alloy. Shear web *I* is then riveted between channel sections.

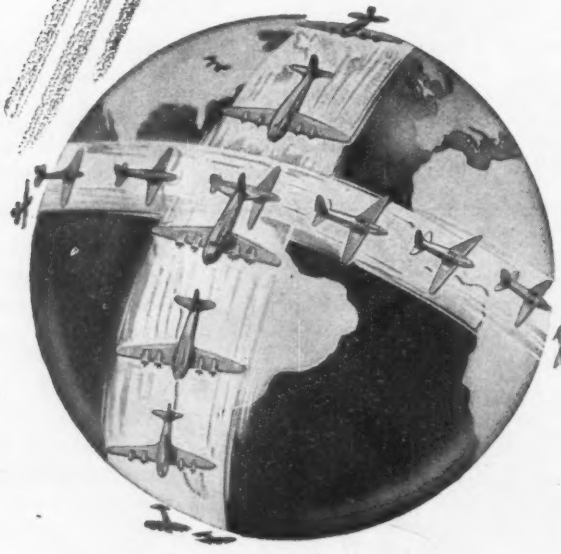


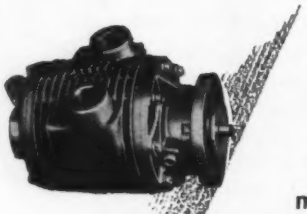




Enlarged views of Junkers Ju-88 auxiliary spar *A*, to which is attached rear section *B*, by means of bolts *C*, which fasten to plate nuts *D*. When rear section *B* is attached to auxiliary spar *A* (as shown in sketch above) the overlapping fillets *E* and *F* slip in place to give upper and lower surfaces a smooth contour as shown at left. (Also see AVIATION's June and August Sketch Books.)

POLICE POWER FOR *Peace* . . .





Down the sea of centuries man has sailed the ship of his dreams in pursuit of the pathway to peace. Perhaps his dreams may soon bear fruit. For the hope of a police power for world peace may yet become a reality at the close of the present conflict. In the struggle for the attainment of that aim, America pays tribute to the tireless efforts of every man and woman engaged in aircraft. For it is THEY who produce the power so essential to police the future peace.

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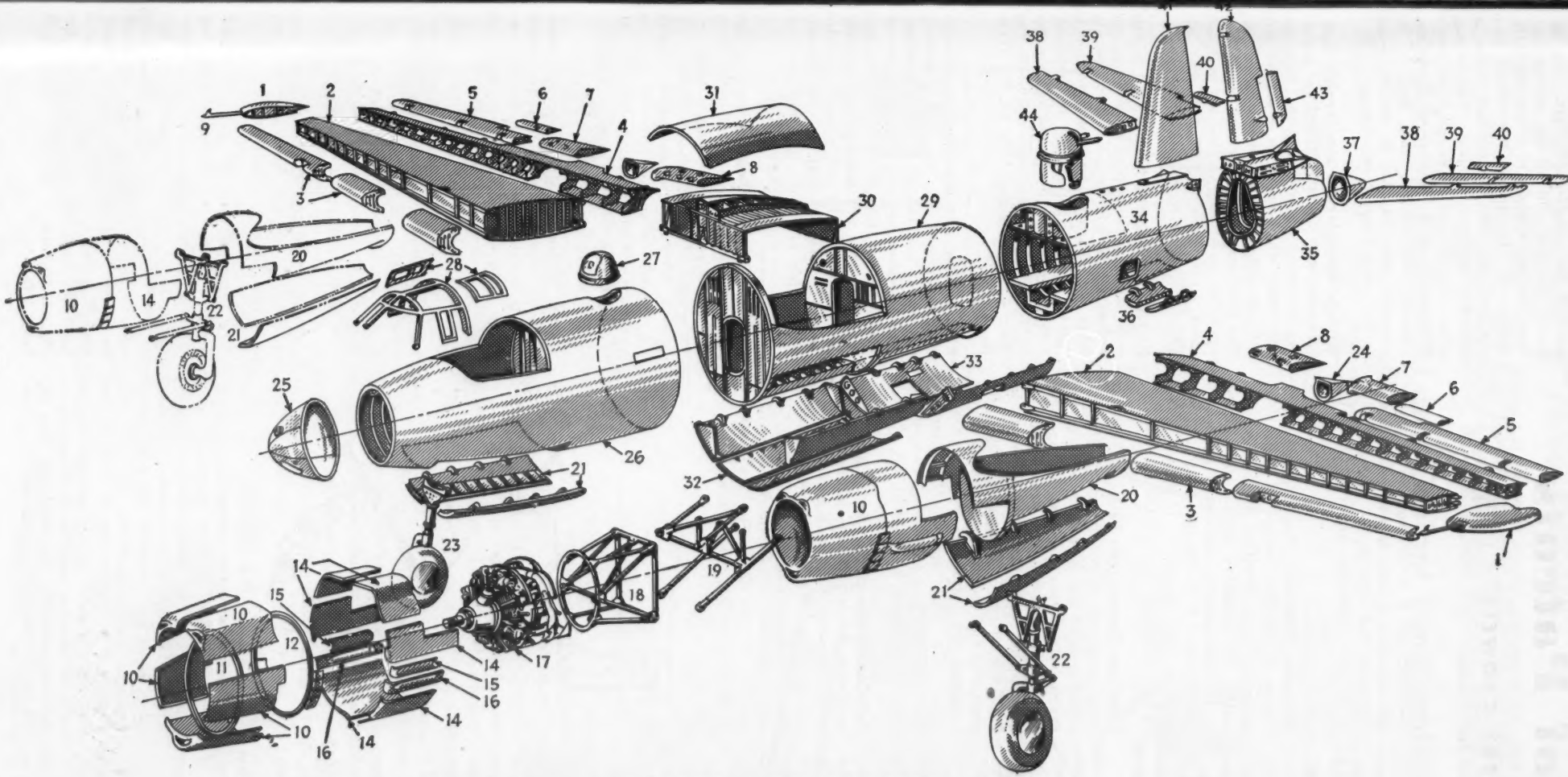


Exploded view showing major components of famed Martin B-26 Marauder

1. Wing tip
2. Outer wing
3. Leading edge
4. Trailing edge
5. Aileron
6. Aileron trim tab
7. Outboard wing flap
8. Inboard wing flap
9. Pitot tube
10. Engine cowling
11. Forward engine ring
12. Aft engine ring
13. Engine cowl flaps
14. Venturi cowling
15. Exhaust stack housing, inner section
16. Exhaust stack housing, outer section
17. Power plant
18. Engine mount, forward section
19. Engine mount, aft section
20. Lower nacelle
21. Landing gear well doors
22. Main landing gear
23. Nose landing gear
24. Nacelle beavertail
25. Transparent nose
26. Forward (nose) fuselage section
27. Avigator's turret
28. Pilot's enclosure
29. Center fuselage section
30. Center wing
31. Center wing cover
32. Main bomb bay doors
33 Auxiliary bomb bay doors
34. Forward tail section
35. Aft section
36. Camera hatch
37. Tail cone
38. Stabilizer
39. Elevator
40. Elevator trim tab
41. Fin
42. Rudder
43. Rudder trim tab
44. Power gun turret

SKETCH BOOK OF DESIGN DETAIL

Review of Patents

By A. HARRY CROWELL
Registered Patent Lawyer

FOLLOWING are digests of some of the more significant patents on recent aviation developments granted by the U. S. Patent Office. Mr. Crowell will be glad to furnish readers information without charge or obligation on approximate cost and procedure in applying for patents and trademark registrations. Address inquiries to him, care AVIATION, 330 W. 42nd Street, New York City. Printed copies of any of the patents listed below are obtainable at 10c. each from the Patent Office, Washington, D. C.

Propeller Blade Packing. Used as a lubricant retainer for variable pitch propeller hub bearings, this packing comprises a wedge-like material which is expanded and held in position by a retainer ring.—2,318,486, filed Apr. 16, '40, patented May 4, '43, W. S. Hoover.

New Propeller Transfer Bearing is an invention concerning oppositely rotating concentric propeller blades and the transfer bearing used in supporting the blades. The innovation lies in the pressure oiling system which keeps the transfer bearing under constant pressure lubrication.—2,318,929, filed June 13, '39, patented May 11, '43, W. S. Hoover.

Flight Training Device. This is a mechanism designed to permit the student to obtain the "feel" of airplane controls. It features a rocking pivot base to enable simulation of some of the fundamental plane maneuvers.—2,319,115, filed Feb. 26, '41, patented May 11, '43, J. E. Crowell.

Reduction Gearing for Propellers. Here, invention concerns a special gearing for the drive of contra-rotating concentric aircraft propellers. The design features simplification so that the overhang weight of the propeller unit is greatly decreased.—2,319,146, filed Jan. 30, '42, patented May 11, '43, S. W. Mansell and W. Payne, assigned to Bristol Aeroplane Co., Ltd.

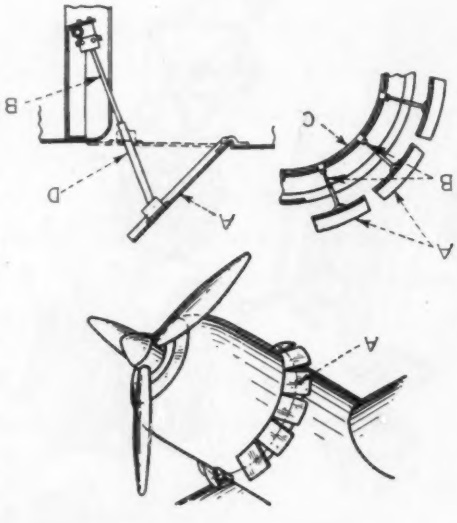
Pitch-Housing Warmer. This development is to prevent impairment, by congealing, of operation of the variable pitch propeller gear mechanism during flights at high altitudes. It consists chiefly of a hood which surrounds the gear housing and a venting vacuum arrangement to draw warm air from the engine over the gear housing.—2,318,233, filed Feb. 5, '41, patented May 4, '43, C. Keller, assigned to Escher Wyss Maschinenfabriken Aktiengesellschaft, Zurich, Switzerland.

Helicopter Governor. Design in this patent concerns an automatic control system to prevent sudden changes in the pitch of the main rotor caused either by stalling of the engine or its acceleration to excessive speeds. The control acts similarly to a governor, and it is designed to be manually operated if the occasion demands.—2,318,259, filed Apr. 6, '40, patented May 4, '43, I. I. Sikorsky, assigned to United Aircraft Corp.

Helicopter Controls. Provided here is a system of auxiliary rotors to control the movements and position of a direct lift craft. The auxiliary rotors are designed to be individually controllable from the pilot's seat.—2,318,260, filed Apr. 9, '40, patented May 4, '43, I. I. Sikorsky, assigned to United Aircraft Corp.

Parachute Harness and Pack. Purpose of this invention is to provide automatic adjustment of the parachute pack to the flyer's body shape, the strap arrangement being such that the size of an airman's body makes very little difference in the fit of the harness. The pack is especially constructed to coordinate with the harness to permit it to adjust itself to the wearer.—2,318,673, filed Apr. 9, '41, patented May 11, '43, G. C. Coleman, assigned to Zeppo Parachute Attachment Co.

Fall-Control Parachute offers construction featuring controllable air-spilling flaps by which the parachutist may govern the rate and direction of his descent. A "tail" is also provided to aid in the steering of the chute.—2,318,674, filed Apr. 9, '41, patented May 11, '43, G. C. Coleman, assigned to Zeppo Parachute Attachment Co.



Mechanical actuator system for operating aircraft accessories is here applied to cowl flaps *A*. They are raised and lowered by screw jacks *B* geared to a motor-driven flexible shaft *C* which encircles the engine compartment. Sleeve *D* protects jack from airstream dirt, and device is said to be mechanically stable in all positions and to increase the usual angle of cowl opening.—2,319,463, filed Dec. 21, '40, issued May 18, '43, W. P. Lear, assignor to Lear Avia, Inc.

Control System for Aircraft. An improved hand control linkage arrangement, incorporating a series of concentric shafts that carry the control movements to a common point on the fuselage frame, is offered in this development. The common pivot arrangement is designed to permit positioning of the controls in a one-step movement.—2,319,285, filed Aug. 5, '39, patented May 18, '43, F. Amiot, vested in the Alien Property Custodian.

Linkage Mounting for aerodynamic members relates to the special linkage mounting necessary to control wing flaps and like units which move in a curved path between extended and retracted positions. The flaps are secured to and moved by a combined parallelogram linkage and bell crank lever system.—2,319,383, filed Jan. 19, '42, patented May 18, '43, E. F. Zap.

Retractable Undercarriage. This landing gear has a combined shock absorbing and retracting mechanism located within the strut so that space for its stowage is reduced and streamlining is improved. A cam arrangement is used to lock the gear in its extended position.—2,319,446, filed Mar. 4, '40, patented May 18, '43, G. H. Dowty.

Rotary Wing Aircraft speed transmission design concerns the connection between the engine and the rotor. The transmission provides for selective or automatic speed changes through three different gear ratios, and the automatic system includes a speed-responsive centrifugal governor control.—2,319,781, filed May 25, '40, patented May 24, '43, C. G. Pullin, assigned to Autogiro Co. of America.

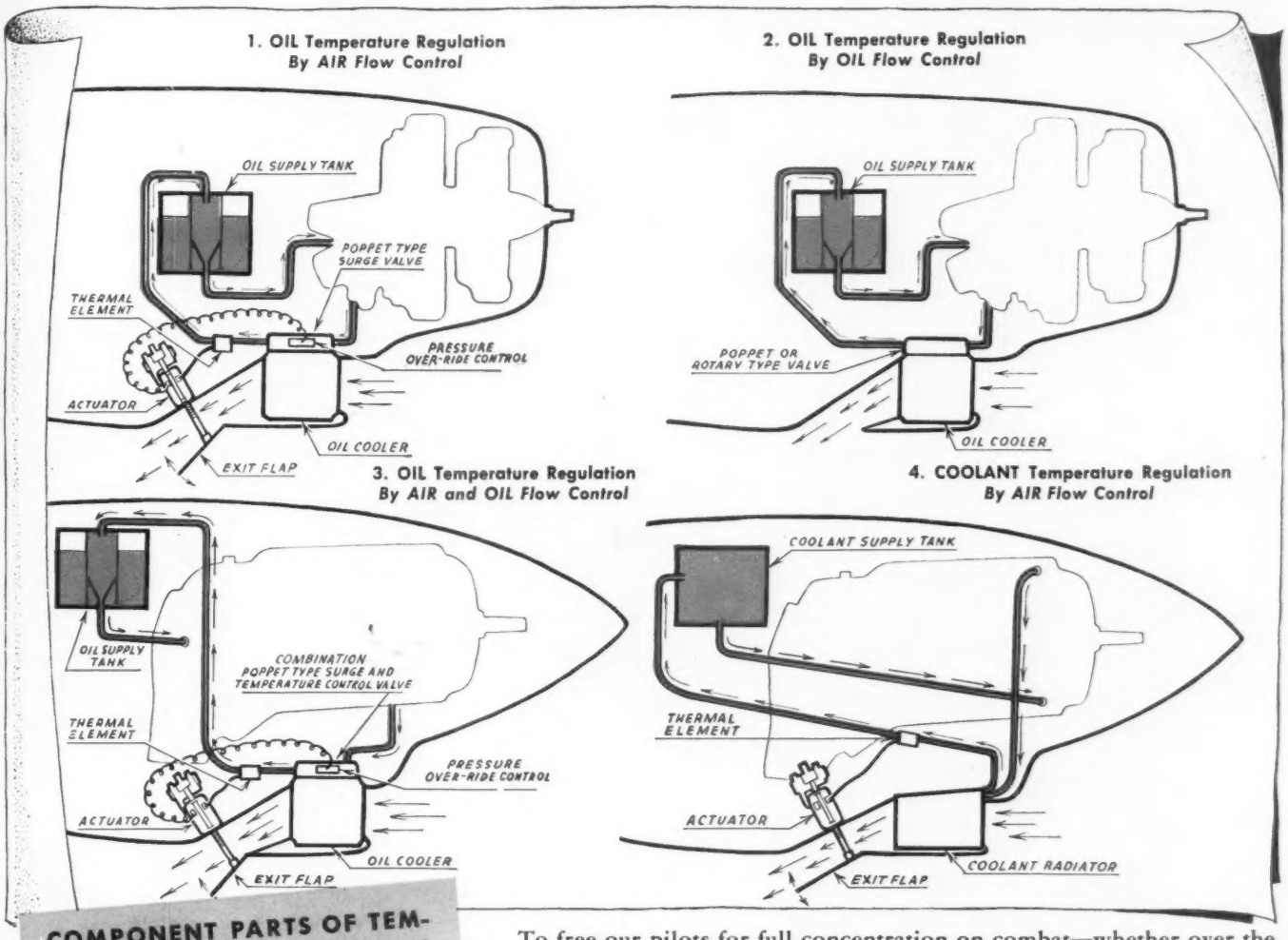
De-Icer Device for removing ice from narrow surfaces, such as struts, pitot tubes, and the like, comprises an inflatable boot. Attached to the leading edge of the strut, it is partially offset so that upon inflation the ice will be moved laterally into the airstream.—2,320,017, filed July 12, '40, patented May 25, '43, A. W. Spicer, assigned to The B. F. Goodrich Co.

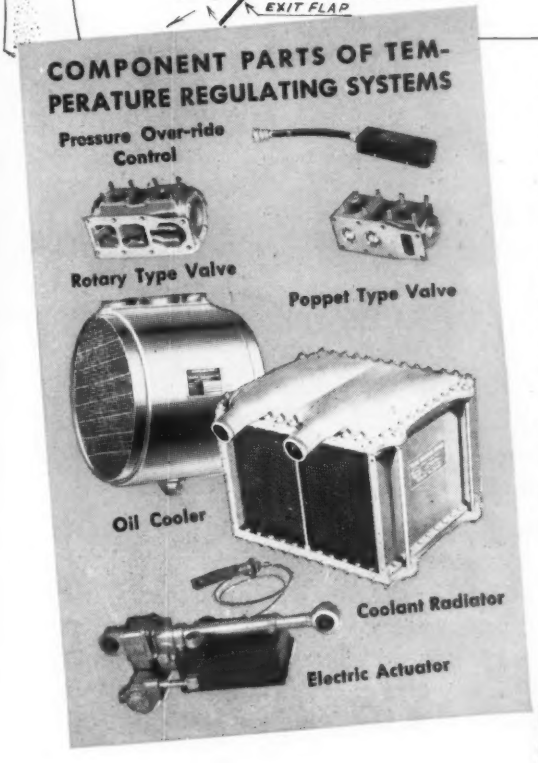
Rubber De-Icer. Patent describes materials used and method of applying rubber shoe to leading edge of wing so that constant thickness is maintained along the wing and drag is minimized. Shoe is comprised of outer and inner sheets which carry inflatable tubes. Upper and lower margins of sheets are reinforced by fabric and held to skin by screws which are made fast in hollow rivets. A layer of sponge rubber is incorporated to protect shoe from shocks and to permit stretching without altering its surface shape.—2,319,968, filed Aug. 3, '40, patented May 25, '43, M. R. Bell and C. S. Stebbins, assigned to B. F. Goodrich Co.

New Mounting employs rubber in method designed to improve means for quieting vibrations. Mountings, comprising opposing faces separated by rubber, are here applied to aircraft engines so that resistance to torque is greater than resistance to yaw and pitch. Direction of greater resistance may be varied as desired.—2,317,190, filed Oct. 3, '40, patented Apr. 20, '43, Richard C. Henshaw, assigned to Lord Mfg. Co.

Young Presents 4 ADVANCEMENTS

in Aircraft Engine Oil and Coolant Temperature Regulation Systems





To free our pilots for full concentration on combat—whether over the torrid tropics or in the frigid stratosphere—YOUNG offers four new automatic Oil and Coolant Temperature Regulating systems, diagramed above. (1) Air flow is regulated by a new thermostatically controlled electric exit flap actuator and a pressure over-ride feature. (2) Oil flow is controlled by a thermostatic and surge protection valve . . . a new rotary type meeting Navy requirements, or a new poppet type, meeting Army requirements. Both mount on the new "AN" flange. (3) A combination of these air and oil flow controls gives improved engine temperature regulation—protects cores and coolers, and assures highest engine efficiency. (4) A finer degree of coolant temperature regulation by air flow control is accomplished by using the Young exit flap actuator. Simple dial setting feature permits the use of electric actuator in either oil or coolant system. Wire or write your performance requirements.

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NO, we don't recommend Joe MaGee's toe-hold welding grip—it's not very practical—but he sure is right in what he says! These nine G-E electrodes make it possible to use alternating-current for more than *75 per cent of all arc welding*. That means easier welding, more uniform deposition, and up to 1/3 *faster* welding than is practical in production welding with direct current.

Each electrode in this line gives excellent results with a-c, and each is backed by an impressive service record. The W-26 is particularly outstanding. Developed especially for first-class a-c welding in the vertical and overhead positions, this electrode complies with all the following specifications: A.W.S. Filler Metal Specification E-6011; Navy Bureau of Ships, Specification 46E3, Grade 111, Class 1; American Bureau of Shipping, Specification H1G and B1G; A.S.M.E. Boiler Code, Paragraph U68.

Thousands of users have found that these electrodes and G-E alternating-current welders are the perfect combination for the fast welding speeds and high-quality welds needed to meet wartime production schedules. If you are not already using a-c welding, it will pay you to investigate its many advantages. Simply contact your G-E arc-welding distributor, or write to General Electric, Schenectady, N. Y.

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"Shucks! with all these good A-C ELECTRODES every welding job is easy!"

75 PER CENT of all Arc Welding Work Can Be Done Most Effectively with G-E A-C WELDERS and These NINE Heavily Coated G-E ELECTRODES

APPLICATION	G-E ELECTRODE	FILLER METAL CLASS (A.W.S.)
Mild steel in any position	W-26	E-6011
	W-20 W-30	E-6012
	W-25	E-6013
Mild steel in the flat position, and horizontal fillets	W-24	E-6020
	W-23	E-6030
High-tensile steel in the flat position, and horizontal fillets	W-54	E-7020
Cast-iron repair	W-83	----------
Wear-resisting surfaces	W-93	----------

ARC WELDING

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672-57-8748

The shape of things to come—like the "Aircar" pictured above—is anyone's guess, but this much is certain:

Out of such improved structural and design developments as the FBT-2 airplane Fletcher Aviation is building today will come a new simplified fabrication technique for the air equipment of tomorrow. The Fletcher fabrication process already has demonstrated its cardinal advantages in such widespread applications for the U. S. Government as in airplanes, airborne refuelling units, gliders, airborne shelters, aircraft seats and other confidential developments.

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Fast production has been achieved in the Fletcher FBT-2 airplane through a combination of design and manufacturing developments. Interchangeability of parts—right and left wings, ailerons, flaps, elevators, stabilizers and landing gear—has simplified production as well as service, while the use of BOTH *plywood and metal in construction produces an airplane of advanced design.*

Army Air Force Standards

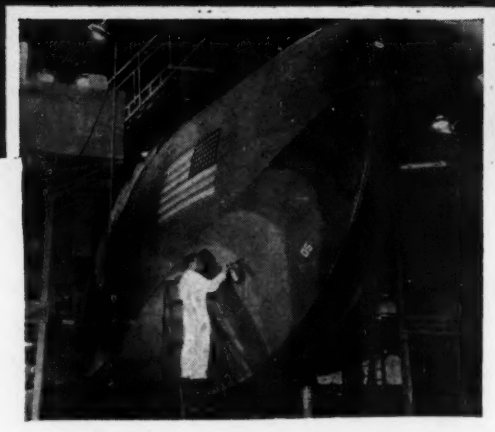
NUMBERING CODE

This is a list of those parts which the AAF has selected as standard for aircraft construction. All persons preparing designs are required to use these standard articles. Prefix AN indicates parts have been adopted as interchangeable standards by the Army and Navy. Persons requiring further data are referred to *U. S. Army Air Corps Standards*.

Number	Name	Sizes	Code rule
AN3 to AN16	Bolt, hex. hd. drilled for pin.	#10 (3/16) to 1 in.	AN no. is dia. in 16th. Dash no. gives length in inches and eighths. A means bolt not drilled. DD means aluminum alloy bolt. Example: AN4DD10A is alloy bolt 1/4 dia. 1 in. and no eighths long, not drilled for pin.
AN23 to AN36	Bolt, clevis.	#10 to 1 in.	AN no. is dia. plus 20. Dash no. gives length in 16ths. Use A after length if not drilled. Example: AN25–16, is 5/16 dia. clevis bolt, 1 in. long.
AN42 to AN49	Bolt, eye, drilled shank.	#10 to 1/2 eye.	Except for AN42 (#10), AN number is eye dia. in 16ths plus 40. Dash no. gives shank length in inches and eighths. Example: AN46–7 is eyebolt with 6/16 hole in eye and 7/8 long shank.
AN73 to AN81	Bolt, hex drilled head.	#10 to 3/4	AN number is dia. in 16th's plus 70. Length in inches and eighths is given by dash no. If NC thread is used A replaces dash. Example: AN76A14 is drilled head NC thread bolt 3/8 dia. and 1 1/2 long. *Exception:* AN81 is bolt 3/4 dia.
AN100	Thimble, wire cable.	3/32 to 1/2 wire.	Dash no. gives cable dia. in 32nd. Example: AN100–5 is thimble for 5/32 dia. cable.
AN111	Bushing, cable.	Same as AN100.	Same as AN100.
AN115	Shackle, cable.	800 to 17,500 lb. breaking strength.	Dash no. is strength in 100-lb. units. Example: AN115–80 is shackle for 8,000 lb. cable.
AN130	Turnbuckle, cable eye and fork.	Short, 4.5 in., long, 8 to 9.5	Dash no. gives strength as in AN115. Use S or T after dash no. to indicate short or long. Example: AN135–16S is short turnbuckle with cable eye and pin eye, breaking strength 1,600 lb.
AN135	Turnbuckle, cable eye and pin eye.		
AN140	Turnbuckle, cable eyes.		
#150	Turnbuckle, fork.		
AN200	Bearing, heavy duty.	#10 to 5/8 bolt.	Dash no. is hole size in 16th. K in place of dash means deep groove. KS is self-aligning. KR is roller bearing. Example: AN200KS4 is self-aligning bearing with 1/4 hole.
AN201	Bearing, medium.	Same as AN200.	Same as AN200 with A after dash no.
AN210	Pulley, control, cable.	Dash no. Pulley dia. Cable dia:	—1A —2A —3A —4A —5A —6A —10A —14A 1.25 2.5 2 3.5 5 6 10 14.5 1/16–3/32 1/8–3/16 3/16–1/4 5/16–7/16 7/16–1/2
AN226	Fastener, post type.	—1 and —3 short shank, —2 long shank, all 3/16 dia. use T after dash no. if threaded. —4 is stud and plate.	
AN230	Grommets, plain and spur.	Commercial 00 to 5.	Dash no. is commercial size, using 20 for 00 and 10 for 0, B for brass, A for plain aluminum, BS for brass spur. Example: AN230-BS1 is brass spur grommet, size 1. Sizes follow no rule.
#235	Hook, lacing.	9/32 to 7/16 wide.	Dash no. is width of hook in 32nd. Example: 235–12 is lacing hook 12/32 wide.
AN240	Eyelet, lacing.	1/8 to 5/16.	Dash no. gives size of hole in 16th. Example: AN240–2 is eyelet with 1/8 hole.
AN250	Hinge, butt, short.	1/2 x 1/2 to 2 x 3.	No rule. Give size required.
AN251	Hinge, continuous.	3/4 to 2 wide, lengths to 72 in.	No rule.
#270	Joint, universal.	1/2 to 1 1/2 dia.	Dash no. is dia. in 16th. A for sq. shafts, B for round. Example: 270A10 is 5/8 dia. joint for square shaft.
AN276	Joint, ball and socket.	For 1/4 shaft only.	No rule.
AN280	Key, Woodruff.	1/16 x 1/2 to 3/8 x 1 1/2.	First dash no. gives thickness in 32nd. Second gives length in eighths. H is used instead of dash if key is of 2330 steel. Example: AN280H204 is nickel steel key 2/32 thick and 4/8 long.

(Continued on page 199)

Pegasus was a piker!



• Not even in the wildest flights of fancy does the winged horse of mythology compare to the everyday miracles performed by the great flying boats of Pan American Airways.

But Pegasus had one advantage! He didn't have to fret over the problems of supplies, parts, repairs and the myriad details of maintenance that make Pan American's world-wide operations all the more remarkable in their amazing efficiency.

Valspar is quite proud of the fact that this far-flung airways system uses certain Valspar Val-Aero finishes at its bases in New York, Miami and Rio de Janeiro.

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Number	Name	Sizes	Code rule
AN285	Lubricator, pressure type.	1/8 pipe thd. size only.	No rule.
AN310 AN315 AN316 AN320 AN355 AN360	Nut, castle. Nut, plain. Nut, check. Nut, shear. Nut, engine, slotted. Nut, engine, plain.	#10 to 1 in.	Dash no. is dia. of bolt in 16th. AN315 and AN316 use R and L after dash no. to indicate right or left threads. AN360 is *black* finish only. Examples: AN360-7 is 7/16 plain engine nut; AN315-6L is 3/8 plain nut, left hand thread.
AN340 AN345	Nut, machine screw, coarse thread. Nut, machine screw, fine thread.	#2 to 1/4-20. #0 to 1/4-28.	Dash no. is screw no. B is used instead of dash for brass and D for alloy nuts. Example: AN345B6 is brass #6 machine screw nut, fine thread.
AN350	Nut, wing.	#6 to 1/2.	Dash no. is screw no. and tpi. in screw sizes, and dia. in 16th for bolt sizes. B for brass. Example: AN350B836 is brass wingnut for 8/36 screw.
#356 #364 #365 #370 #371	Palnut. Nut, thin fiber lock. Nut, fiber lock. Nut, thin metal lock. Nut, metal lock.	Commercial product made in all si.es.	Dash no. gives dia. in 16th, followed by tpi. as part of same number. Example: 356-624 is palnut for 3/8 bolt, 24 tpi.
#366 #367 #368 #369	Nut, plate, fiber lock and plain. As 366 but c's'k. Nut, plate, metal lock. As 368 but c's'k.	Machine screw.	Dash no. is screw no. followed by tpi. D is used for alloy and F for fiber instead of dash. Example: 366DF1032 is fiber lock alloy nut, #10 screw, 32 tpi.
AN380	Pin, cotter.	1/16 to 1/4 dia., 1/2 to 4 long.	First dash no. gives dia. in 32nd. Second gives length in quarters. B is for brass, C for corrosion resistant, in place of first dash. Examples: AN380-3-8 is plain steel cotter 3/32 dia. and 2 long.
#385	Pin, taper.	#6/0 to #6.	First dash no. is pin no. Second dash no. is length of taper in eighths. Example: 385-60-4 is taper pin # 000000, 4/8 long.
#386	Pin, taper, threaded.	#1 to #11.	Same as #385, except that A is used if not drilled for cotter.
AN392 to AN406	Pin, flat head.	1/8 to 1 in. dia.	First dash no. is dia. in 16th plus 390. Second is length in 32nd from under head to inside edge of pinhole. Example: AN395-39 is flat head pin 5/16 diam., 39/32 long.
AN415	Pin, lock.	Used with AN226.	AN415A is for single stud, AN415 is made in even inches up to 7. Dash no. is length in inches.
AN420 AN425 AN430 AN435 AN441 AN442 AN455	Rivet, c's'k, iron or copper. Rivet, aluminum alloy, c's'k hd. Rivet, aluminum alloy, round hd. Rivet, iron, round hd. Rivet, flat hd., iron or copper. Rivet, flat hd., alum. alloy. Rivet, brazier hd., alum. alloy.	1/16 to 3/8.	First dash no. is dia. in 32nd. Second dash no. is length in 16th. C replaces first dash for copper, D for 17ST, DD for 24ST, AD for A17ST. Examples: AN425D2-2 is 17ST rivet, 1/16 dia., 1/8 long. AN420C5-8 is copper c's'k hd. rivet, 5/32 dia., 8/16 long.
AN450	Rivet, tubular.	1/8, 9/64, 3/16 dia.	First dash no. gives dia. in 64th. Second dash no. gives length in 32nd. First dash is replaced by A for deep c's'k hd. B is for flat hd., C for brazier hd., D for shallow c's'k hd. Second dash is replaced by A for copper, B for brass, C for alloy. Examples: AN450B8B3 is flat head brass rivet, 8/64 dia., 3/32 long.
AN481	Clevis, rod end, brazing.	For 3/8 x .035 tubing.	—1, —2 take 1/4 pin, —3, —4 take 3/16 pin.
AN486	Clevis, rod end, adjusting.	For 1/4-28 NF thd.	Sizes and dash nos. as AN481.

To be continued next month

7,000,000 miles . . . 50,000 passengers!

● SINCE MAY, 1939, Pan American Clippers have flown the Atlantic more than 1400 times . . . carried more than 50,000 passengers . . . logged more than 7,000,000 air miles.

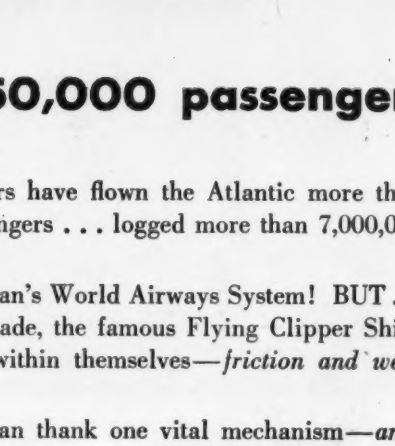
And this is only one division of Pan American's World Airways System! BUT . . . before these record-breaking flights could be made, the famous Flying Clipper Ships had to overcome most formidable obstacles, within themselves—*friction and wear* of moving parts.

For this notable mechanical triumph, we can thank one vital mechanism—*anti-friction bearings!* They reduce friction . . . keep metal cool . . . postpone wear . . . and maintain precise location of parts.

NEW DEPARTURE ball bearings, by the *tens of millions*, are used in planes, ships, tanks, trucks, jeeps—and in the *machines* which make them. In fact New Departure has a major responsibility in the whole ball bearing war production program.

3177

New Departure
BALL BEARINGS



Nothing Rolls Like a Ball

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONNECTICUT

SIDE SLIPS

• Dig beneath the froth of glamour publicity which engulfed the WAFS and you find serious, hard working gals who are really doing a job. But, bless 'em, they're still delightfully feminine. Deep in the sweltering heart of Texas the other day, five of them had just completed a rough day's flight to deliver some primary trainers. They were definitely wind-burned, tired-looking young ladies as they struggled into the terminal loaded down with suitcases and bulky parachute packs. In a remarkably short time, however, they reappeared looking very trim in jacket-and-skirt uniforms of the Air Transport Command's Ferrying Division. Even the fire—most of it anyway—had gone from their sun and wind burn in the very short time before they boarded the airliner for the long haul back to base. Then, as before, they quietly minded their own business.

• We know at least one Air Corps captain who's a walking ad for the helicopter. Flying over some jungles as an observer, he and a sergeant had to bail out. The pilot intended to be last out, but he finally was able to right the plane and fly home. Meanwhile, the sergeant had parachuted to earth near some natives, who had him back at his base "almost in time for chow." But the captain landed in a tree (he swears it was 200 ft. high) about five miles away. Making a rope of his parachute shroud lines, he finally got to the jungle floor and fought his way to a small, jungle-wrapped clearing, where he was soon located by his squadron mates. For five days they dropped supplies—and snide notes demanding receipts—while a rescue party forced its way in.

Point is he stoutly maintains that a helicopter would have had him, too, home "in time for chow." He got some satisfaction out of the deal though. By staying put and receiving regular aerial supplies, he came through it all in much better shape than the rescue party.

• To the old timers, equipment which today's war pilots fly is nothing short of wonderful. But with all the gadgets and power—particularly the latter—at their disposal, some of the OT's still insist, the youngsters really miss a lot of excitement. There was the chap, for instance, who after living through the last war bought himself an OX-5 *Jenny* with which he started barnstorming.

It seemed, however, that he never could clear the perennial mountain passes with more than 15 ft. to spare, and he unconsciously helped old *Jenny* through with body English—pulling straight up on the stick. But one day he had less than the usual 15 ft. and gave an extra little pull—just the wrong thing to do, for he pulled the stick right out of the socket. Says he doesn't know to this day by how many inches he really cleared the pass. He was too busy getting the stick back in place.

• Another faithful old *Jenny*—a clipped wing version—met a sad end. Used by a university flying club, she sat about without benefit of hangar or other weather protection. One day a club member went out, shortly after a long; hard rain, and warmed her up. He didn't take off. He *staggered* off—clearing the surrounding mesquite brush by fewer-than-normal inches. Then he "cruised" at full throttle for quite a while trying to get a few feet of altitude, but without success.

Finally, approaching the inevitable surrounding hills, he decided he'd better get back to the field, and so he started into a very shallow bank for a wide left turn. But *Jenny* would have none of this shallow stuff—the wing went right on down, but sharp, splattering the airplane across the desert. Unhurt, the pilot climbed out, but he began to doubt his sense when he saw water dripping from the wings. Seems a lot of the rain had leaked into them and the second he started to make his turn, it all obeyed the law of gravity and moved to the left. The weight was just too much for any *Jenny's* controls.

• It's very nice to know that a glider, with a ton-and-a-half load, has been successfully towed across the Atlantic. But, is it pertinent to ask "how much, if any, load did the tow plane carry?"

Maguire says he's never heard of an engine leaking gasoline before, but he'll try anything to get more than his ration allowance.

You get a good idea of how well the aircraft manufacturing and air transportation industries rely on the Cuno method of fluid protection when you learn that 85% of the planes "coming and going" at the Philadelphia Municipal Airport are Cuno-equipped.

"Cuno-equipped" means that the engine lube system or hydraulic control system or both are guarded against damage due to fluid-borne solids by the Cuno type of edge filtration — affording protection that is positive, continuously-cleanable, trouble-free, permanent.

Cuno was first in the development of filters for removing sludge from aircraft engine lubricating systems. Cuno is first, today, in the choice of manufacturers and airlines — proven by millions of miles of successful flight.

CUNO DESIGN FEATURES

Light, compact, yet handles full flow — ideal for aircraft applications.

All-metal filter discs are permanent, non-collapsible — nothing to replace.

"Comb-action" cleaning is positive — removes imbedded as well as adherent accumulations.

Continuously-cleanable while in operation — either manually or automatically by means of a tiny built-in hydraulic motor.

Excess capacity insures unvarying flow at low operating temperatures.

CUNO SERVICE FEATURES

Cooperating closely with aeronautical engineers, Cuno engineers have broadened the scope of Cuno applications to cover such other services as glycol heating systems.

Furthermore, Cuno's advisory-maintenance staff follows through on all installations — making sure that operating crews are completely familiar with principle, construction and proper maintenance. Experience has proved that peak performance can be maintained easily and with a minimum expense of time.

Cuno Filters help safeguard 85% of flights to and from Philadelphia

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Cuno Auto-Klean strains full flow of engine lubrication oil. Filter built in as an integral part of engine — self-cleaning in flight — no external connections.

SUPERCHARGER LUBE OIL:

Supercharger bearings are protected against oil-borne particles by a Cuno Auto-Klean which filters oil taken from main engine system before passing it to the supercharger.

HYDRAULIC CONTROL SYSTEM:

Cuno Auto-Klean, installed in high pressure line beyond the engine-driven pump, prevents damage or clogging of working parts in hydraulic control system.

GLYCOL HEATING SYSTEM:

Glycol — from storage tank — passes through exhaust heater and cabin heat exchangers to provide hot water and galley heat for cooking. Cuno Auto-Klean filters glycol at 270°F. — protects working parts, prevents accumulation on heat exchanger tubes.

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THE "FILTER-FINE" STRAINER

CRUISE CONTROL For Flying Efficiency

Part III . . . Power Control

By

R. DIXON SPEAS, *Asst. to Vice-Pres. Engineering*
JERE T. FARAH, *Chief Flight Analyst*
SANFORD HINTON, *Flight Analyst*
American Airlines

Revealed are the latest methods of cutting engine fuel costs through the use of meters, charts, and calculators.

CONTROL OF THE CRUISING FLIGHT of an airplane basically is control of the power output of the engines under the prevailing conditions. In order to make possible this power control, some method must be adopted for accurately setting power in flight, since it is upon this precept that all cruising control depends.

Various means have been devised for the purpose, the more important being: (1) The direct mechanical type, and (2) the indirect or predicative type which depends upon setting up conditions within the engine which are known to produce certain powers.

Mechanical types of power-determining apparatus include torquemeters, thrustmeters, and the recently developed horsepower meter.

In the equation Hp. = PLAN/33,000, where P = M.e.p. during cycle; L = piston stroke in feet; A = piston area; and N = Rpm., the force P × A becomes torque when converted from reciprocating to rotary motion by the crankshaft. Thus the torque developed varies directly as P × A. But horsepower is a time-rate quantity (work done per unit time) so power developed is proportional to both P × A and N. For a given engine, A and L are constant, so the power formula becomes Hp. = P × N/Constant.

It was shown above that torque is directly proportional to P, therefore, by means of a suitable conversion factor, measurement of torque becomes a measurement of mean effective pressure.

The torquemeter is designed to measure the torque delivered to the propeller shaft, as shown in Fig. 1. Virtually all modern radial engines are equipped with planetary reduction gearing between engine and propeller. The crankshaft drives the outer ring, the propeller shaft is attached to the planetary pinion gears, and the center or "sun" gear (which is stationary when no torquemeter is installed) is pivoted on its center and connected at its periphery (by means of an arm) to a piston in a cylinder containing oil.

During engine operation the sun gear is subjected to a reaction torque proportional to the mean effective pressure. This torque exerts a pressure on the oil in the cylinder directly proportional to the propeller torque, and pressure is transmitted to a gage in the cockpit, where it is used as a measurement of power in conjunction with an engine tachometer and a conversion constant. Thus, Torquemeter hp. = Torquemeter pressure × Rpm./Constant.

The torquemeter is a rugged yet accurate instrument which makes possible very close power settings and control. Usually, the torquemeter is regarded only as an instrument for accurate test flight work, but future requirements in power control will no doubt cause its adoption in routine airline operation.

A thrustmeter measures the thrust force actually being produced by the propeller, usually through a special type of engine suspension or in the nose section itself. This instrument measures a quantity which is correlated to engine power by propulsive efficiency, so its use in routine flying is limited by the fact that conditions seriously affecting propeller efficiency, such as icing, could cause the engine power limits to be greatly exceeded if a specified thrust were maintained. The thrustmeter has been used in flight test work with some measure of success.

The horsepower meter combines electrically the torque output with the engine speed to produce a direct indication of developed horsepower. This appears to be the most satisfactory instrument in routine power control, since it gives direct horsepower readings. It should be remembered that the rpm. for each power should be that for max. b.m.e.p. Thus, some indication of rpm. would be necessary as a guide for computing power.

When graphs are used to determine engine power, four main variables must be known: (1) Rpm., (2) manifold pressure, (3) pressure altitude, and (4) temperature of air entering carburetor.

An engine produces more power when the rpm. are increased and also when the pressure of the charge entering the cylinders is greater. Variation of power with altitude is more complex because the power increases with the weight of air entering the cylinders,

because of the resulting increase in manifold pressure. If rpm., manifold pressure, and air temperature are all constant, a change in altitude produces a corresponding change in power. This is because of the variation in back pressure against the exhaust, due to differing air density.

Temperature of the entering air affects the power because it is a measure of the amount of energy which is available from burning the charge in the cylinder. The lower the temperature, the greater is the density of the air, with the result that more fuel can be burned, generating more power.

Engine power charts are usually in two parts: (1) Sea level calibration, and (2) altitude calibration. The sea level chart is shown in Fig. 2. Its use is self explanatory. For example, at sea level and standard temperature an engine is running at 1,800 rpm. with a manifold pressure of 30 in. Hg. To calculate, simply follow the line of 30 in. manifold pressure up to the intersection of the 1,800 rpm. line, then follow across to the right and the power reading is 545 hp. The sea level calibration plots the hp. available at sea level and the standard temperature for any combination of rpm. and manifold pressure.

The second part of the power curve is the altitude calibration shown in Fig. 3. This is obtained by running the engine at full throttle at various altitudes, with a full range of rpm. at each altitude. For example, tests would be made at sea level, 5,000 ft., 10,000 ft., 15,000 ft., and 20,000 ft., and at each altitude the engine would be run at full throttle at a full range of rpm. from 1,400 rpm. to 2,200 rpm. at intervals of 200 rpm. Results would then be plotted as in Fig. 3.

Full throttle power at any altitude and rpm. is found by entering the graph at the desired altitude, moving to the rpm. under consideration, then left to the hp. scale. The full throttle hp. available at that altitude and rpm. is read from the hp. scale at the left. Running diagonally across the graph are lines of constant manifold pressure. These are determined by noting the full throttle manifold pressure at each rpm. and altitude reading and then drawing in the manifold pressure curve.

We have thus, in the two examples, found the hp. available at sea level, part throttle, with 1,800 rpm. and 30 in. manifold pressure and with the same rpm. and manifold pressure at full throttle at 10,500 ft. When the two diagrams are placed side by side, there is shown the usual presentation of engine power charts. The question now

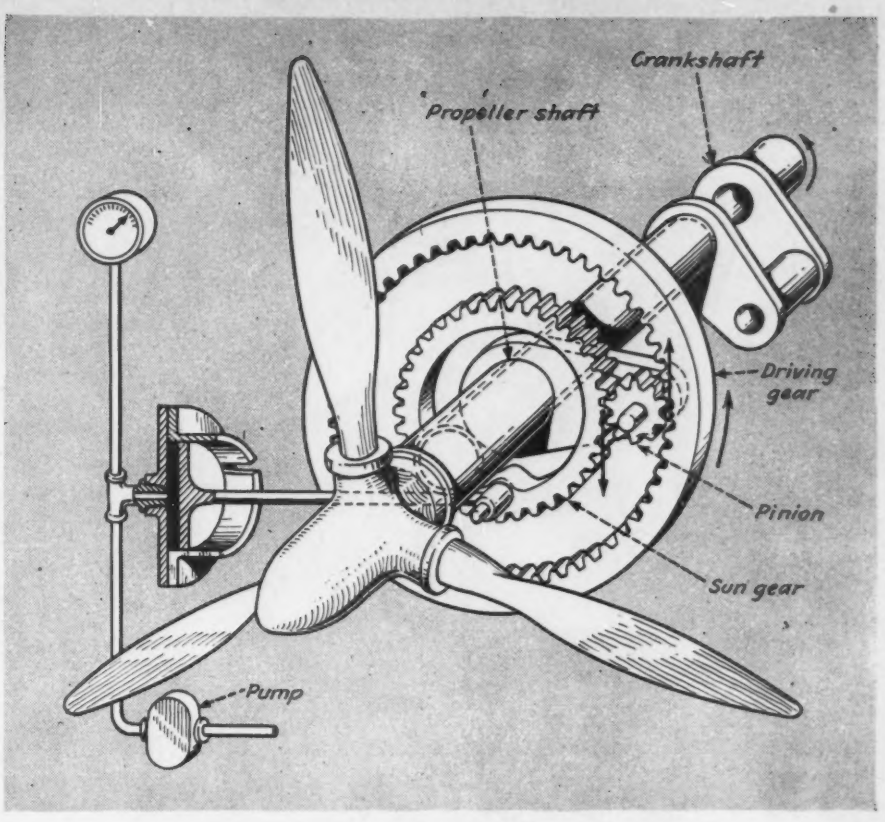


Fig. 1. Diagram of essential parts of torquemeter.

arises as to how power is determined at part throttle at some intermediate altitude. If the power at sea level and the power at altitude for any combination of rpm. and manifold pressure are joined by a straight line *A—B*, the power at any altitude for that combination of rpm. and manifold pressure is known. In the example, the power available at 3,000 ft., for 1,800 rpm. and 30 in. manifold pressure, is 570 hp.

The line connecting the power at sea level and the full throttle power at altitude for any rpm. and manifold pressure, shows the pressure at all altitudes for that combination. Since by the construction of the curve the power at 10,500 ft., 1,800 rpm. and 30 in. manifold pressure is full throttle power, that combination is not possible at any higher altitude. The lines connecting the sea level power with full throttle altitude power are not exactly parallel, but they are nearly enough so that they

WRIGHT G-102 ENGINES RPM-MANIFOLD PRESSURES—300-625 HP.

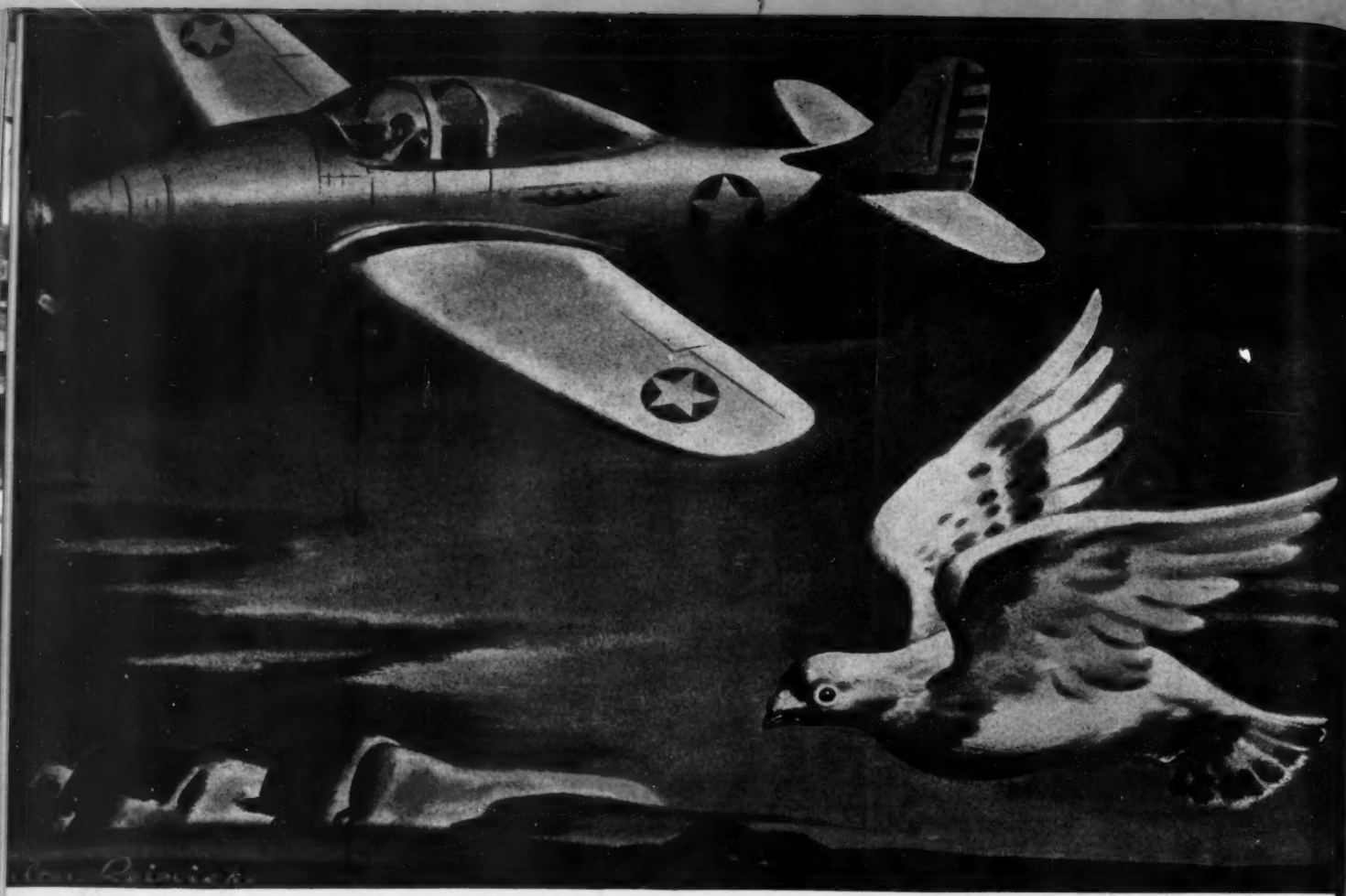
Altitude		1,000	2,000	3,000	4,000	5,000	6,000	7,000	8,000	9,000	10,000	11,000	12,000
625 HP.	RPM.	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100
	Man. Pr.*	30.0	29.5	29.2	28.9	28.6	28.3	28.0	27.7	27.4	27.1	26.8	26.5
600 HP.	RPM.	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
	Man. Pr.	29.4	29.0	28.7	28.5	28.2	27 8	27.6	27.2	27.0	26.7	26.4	26.1
550 HP.	RPM.	1,850	1,850	1,850	1,850	1,850	1,850	1,850	1,850	1,850	1,850	1,850	1,850
	Man. Pr.	28.6	28.2	28.0	27.6	27.3	26.9	26.6	26.3	26.0	25.7	25.4	25.1
500 HP.	RPM.	1,700	1,700	1,700	1,700	1,700	1,700	1,700	1,700	1,700	1,700	1,700	1,750
	Man. Pr.	28.1	27.6	27.3	27.0	26.6	26.3	26.0	25.6	25.4	25.0	24.7	24.2
450 HP.	RPM.	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,550	1,600
	Man. Pr.	28.2	27.7	27.4	27.0	26.7	26.3	26.0	25.6	25.3	25.0	24.2	23.5
400 HP.	RPM.	1,350	1,350	1,350	1,350	1,350	1,350	1,350	1,350	1,350	1,400	1,450	1,500
	Man. Pr.	28.2	27.9	27.4	27.0	26.7	26.2	25.9	25.5	25.2	24.3	23.5	22.6
350 HP.	RPM.	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,250	1,250	1,300	1,300	1,350
	Man. Pr.	28.6	28.2	27.6	27.2	26.8	26.4	26.0	24.8	24.5	23.5	23.2	22.2
300 HP.	RPM.	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200
	Man. Pr.	26.4	25.9	25.4	25.0	24.6	24.2	23.9	23.5	23.1	22.8	22.4	22.0

* Manifold pressure correction for temperature difference

Condition	Part Throttle	Full Throttle
If carburetor air is *above* standard	Add .5" manifold pressure for each 20° F. above std.	Add 20 rpm. for each 20° F. above standard.
If carburetor air is *below* standard	Subtract, .5" man. press. for each 20° F. below std.	Subtract 20 rpm. for each 20° F. below standard.

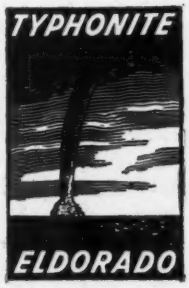
NOTE: Figures to right of heavy line are full throttle operation.

Fig. 4. Standard pilot's power table, Wright G-102 engines.



WITH BLUEPRINTS and WITHOUT

The bird of nature is a creation without blueprints. The bird of man springs from his mind and hand as he works at the drawing board with pencils. The best drawing pencil is none too good for this work. We believe we furnish that indispensable part in Dixon's *Typhonite* ELDORADO drawing pencils.



The new booklet describing the Typhonite process is offered to aeronautical draftsmen. Write for your copy mentioning this publication.

TYPHONITE
ELDORADO

PENCIL SALES DEPARTMENT 61-J9 • JOSEPH DIXON CRUCIBLE CO. • JERSEY CITY, N. J.

may be drawn this way for the sake of simplicity.

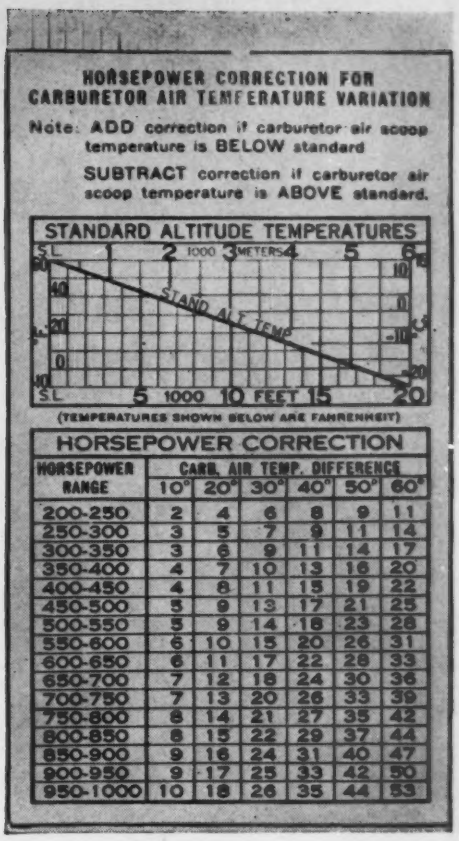
Effect of the temperature of the air entering the carburetor is another important variable, because the power produced varies as the square root of the standard absolute temperature at that altitude divided by the actual absolute temperature.

For instance, assume that 600 hp. would be produced at 10,000 ft. Standard temperature at 10,000 ft. is 23 deg. F. while observed temperature is 3 deg. F. What power is being produced? First the temperatures must be converted from deg. F. to deg. absolute by adding 460 deg. to each figure, making them 483 deg. and 463 deg., respectively. The power at 10,000 ft. then is—600 hp. $\times \sqrt{483/463} = 612$ hp.

Examination of these figures shows that a difference of 12 hp. or 2 percent of the total hp. results from a change of 20 deg. F. This gives us a very simple rule: "Horsepower varies inversely 1 percent for each 10 deg. F. difference between actual and standard temperature."

To find the power at 1,800 rpm., 30 in. manifold pressure, 3,000 ft. pressure altitude and 80 deg. F.: It has already been found that at standard temperature, 570 hp. was available at 3,000 ft. Standard temperature at 3,000 ft. is 50 deg. F., but the temperature in this case is 80 deg. or 30 deg. hotter than standard, with a power reduction of 3 percent, resulting in 553 hp.

GR 1820 G102
WRIGHT CYCLONE
BRAKE HORSE POWER
ALTITUDE IN THOUSANDS OF FEET (READ ALONG STRAIGHT EDGE)
WRIGHT
CRUISING POWER
CALCULATOR
WRIGHT
AIRCRAFT ENGINES
INSTRUCTIONS
Hold calculator so that pressure of fingers on slide thru opening will keep the slide firmly against indexing edge at left of case.
Set diagonal top edge of case on intersection point of R. P. M. and manifold pressure. From observed altitude point on diagonal, read horizontally to horsepower shown on left of slide.
Correct horsepower for carburetor air scoop temperature (not mixture temperature) according to tables on reverse side.


HORSEPOWER CORRECTION FOR CARBURETOR AIR TEMPERATURE VARIATION
Note: ADD correction if carburetor air scoop temperature is BELOW standard
SUBTRACT correction if carburetor air scoop temperature is ABOVE standard.
STANDARD ALTITUDE TEMPERATURES
STAND. ALT. TEMP.
5 1000 10 FEET 15 20
(TEMPERATURES SHOWN BELOW ARE FAHRENHEIT)

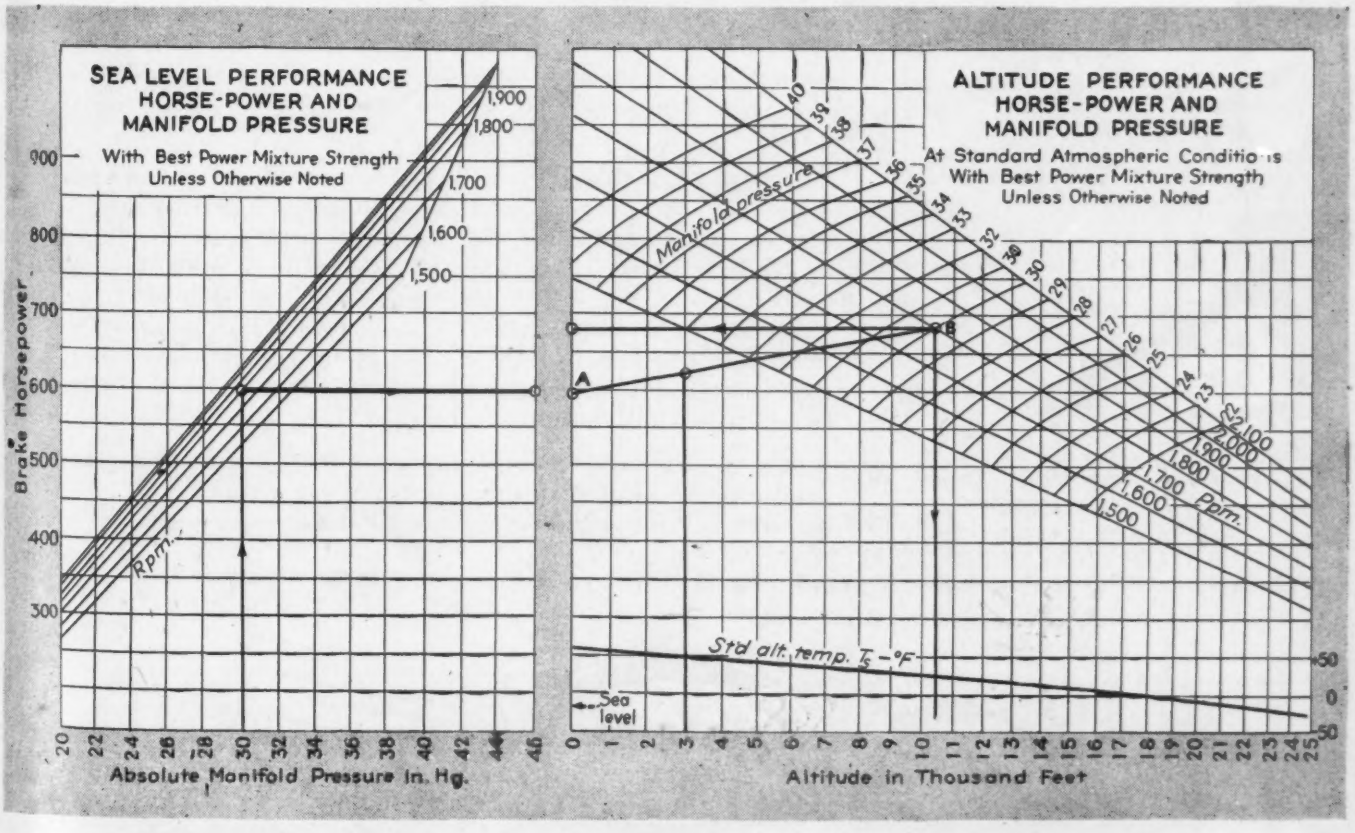
HORSEPOWER CORRECTION

HORSEPOWER RANGE	CARB. AIR TEMP. DIFFERENCE					
	10°	20°	30°	40°	50°	60°
200-250	2	4	6	8	9	11
250-300	3	5	7	9	11	14
300-350	3	6	9	11	14	17
350-400	4	7	10	13	16	20
400-450	4	8	11	15	19	22
450-500	5	9	13	17	21	25
500-550	5	9	14	18	23	28
550-600	6	10	15	20	26	31
600-650	6	11	17	22	28	33
650-700	7	12	18	24	30	36
700-750	7	13	20	26	33	39
750-800	8	14	21	27	35	42
800-850	8	15	22	29	37	44
850-900	9	16	24	31	40	47
900-950	9	17	25	33	42	50
950-1000	10	18	26	35	44	53

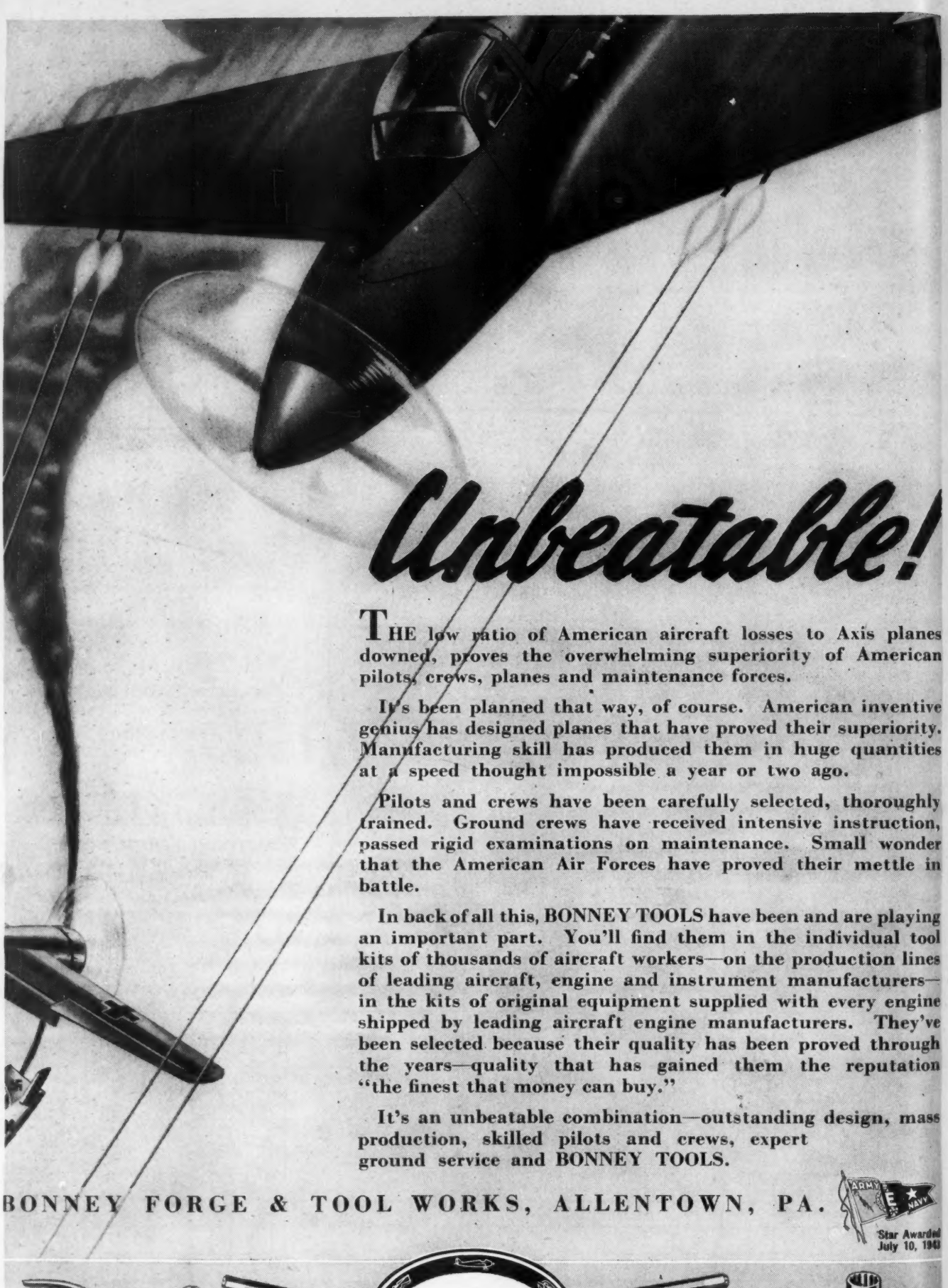
Fig. 5. The Wright cruising power calculator. Front of device is at left, back at right.

For engines having more than one supercharger gear ratio, a separate set of curves must be drawn for each ratio.

(*Turn to page* 310)



Figs. 2 and 3. Graphs for engine performance at sea level (left) and at altitude (right).



Unbeatable!

THE low ratio of American aircraft losses to Axis planes downed, proves the overwhelming superiority of American pilots, crews, planes and maintenance forces.

It's been planned that way, of course. American inventive genius has designed planes that have proved their superiority. Manufacturing skill has produced them in huge quantities at a speed thought impossible a year or two ago.

Pilots and crews have been carefully selected, thoroughly trained. Ground crews have received intensive instruction, passed rigid examinations on maintenance. Small wonder that the American Air Forces have proved their mettle in battle.

In back of all this, BONNEY TOOLS have been and are playing an important part. You'll find them in the individual tool kits of thousands of aircraft workers—on the production lines of leading aircraft, engine and instrument manufacturers—in the kits of original equipment supplied with every engine shipped by leading aircraft engine manufacturers. They've been selected because their quality has been proved through the years—quality that has gained them the reputation "the finest that money can buy."

It's an unbeatable combination—outstanding design, mass production, skilled pilots and crews, expert ground service and BONNEY TOOLS.

BONNEY FORGE & TOOL WORKS, ALLENTOWN, PA.

ARMY E NAVY

Star Awarded July 10, 1943

W.O.#1

THE GOVERNMENT-APPROVED PHOSPHATIZER WHICH EXCELS IN AIRCRAFT MAINTENANCE

MAKES PAINT STICK TO ALL AIRCRAFT METALS (Except Magnesium). Removes and Prevents Corrosion. For preparing aluminum and other alloy parts before painting. For removing lead stains caused by ethyl gasoline combustion.

TURCO W. O. #1, the rapid, low-cost phosphatizing method used extensively by many aircraft manufacturers, is versatile—quick and dependable in action and easy in application. This process is equally successful either for completely assembled units or for touch-up work.

TURCO W. O. #1 provides the required passivation for aluminum and aluminum alloy surfaces, as well as all other structural metals except magnesium. It provides maximum adhesion for paint and other finishes. It inhibits rust, thus preventing oxidation of any exposed area.

TURCO W. O. #1 is easily applied by hand or by tank immersion. The customary dilution is 1 part TURCO W. O. #1 to 4 parts water. The hand method requires only the use of a sponge or brush. Rinse with clear water and wipe dry with clean rags. For smaller parts, use tank method. Immerse in solution for 15 minutes; then rinse thoroughly.

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ON YOUR LETTERHEAD, PLEASE

Photo by Office of War Information

PROTECTING THE "Nerve Center" OF A B-25 BOMBER

The young lady is attaching terminals to the panel of an electrical junction box, shortly to become the "nerve center" for a big B-25 bomber. To protect against static interference, incoming and outgoing wiring is encased in Flexible Low-Tension Shielded Conduit made by American Metal Hose.

Wherever planes fly, this battle-tested conduit is playing its part in supporting brilliant performance... enabling radio signals and directions to come in clear and undistorted. It is one of the important "tremendous trifles" that are helping American wartime aviation set so many outstanding records.

American Metal Hose makes a complete line of fittings and accessories for American Flexible Low-Tension Shielded Conduit. Both fittings and conduit conform to A-N, A-C and NAF specifications. We are also prepared to make complete assembly of conduit and fittings to meet individual specifications, thus conserving valuable time on the production line for aviation plants. Inquiries will receive prompt attention.

ANACONDA *American Metal Hose*

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Continuous Overhaul On PAA "Clippers"

By DAVID BAKER
Assistant Editor, "Aviation"

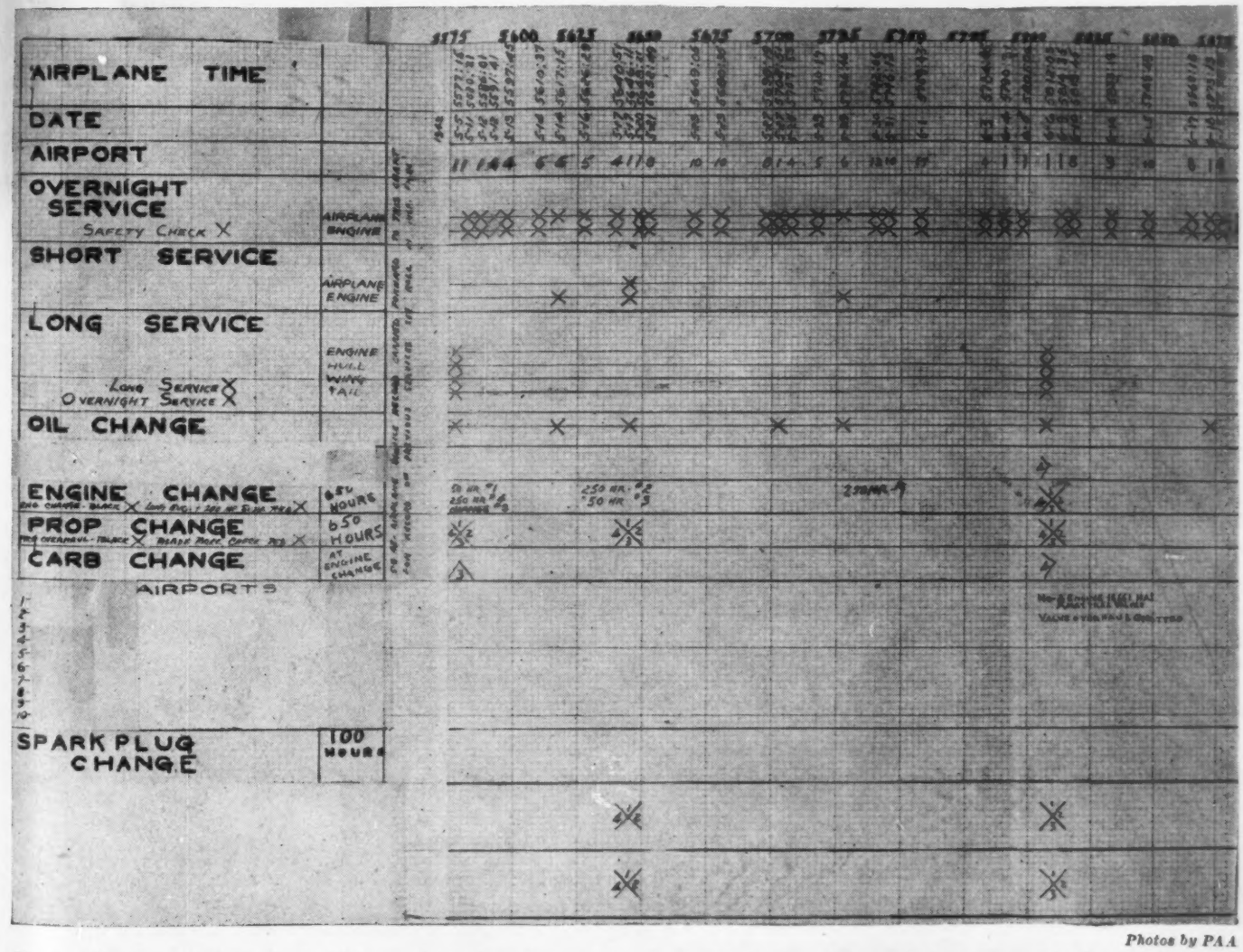
Through a highly efficient system of progressive overhaul, Pan American maintains its well known flying boats without interruption of operation. And the carefully keyed records which "keep the tab" can be of great profit to future operators of large planes.

IN PROVIDING intercontinent air service involving long non-stop ocean hops between widely spread bases, Pan American Airways maintenance men had the job of combining safety with non-interruption of service, meanwhile facing the problems of wide geographical distribution of facilities.

The only way of achieving success was through a system of continuous overhaul, which is very similar in principle to maintenance of steamships, where work begins at one end of a ship, proceeds toward the other end—and by the time the whole ship has been covered it's time to start in again. The system has been applied, in a considerable degree, to standard land air transports, where the limited number of planes has made it necessary for some companies to keep them in service every possible minute. But this involves periodic dismantling of the land craft for reasons of maintenance accessibility.

The policy is particularly applicable to large flying boats, for they can be reached everywhere from the inside, even into the wing tips. And they have the advantage over steamships of being easily hauled out of the water for outside hull work.

So successful has the system been



Photos by PAA

Fig. 1. Overhaul control chart which records airplane time and all service checks performed. NC- number would be entered at upper left. Airports are normally listed by number and entered in appropriate column to show where service was performed. "Long Service" is designated by a black X, "Overnight Service" by a red X. From "Engine Change" through to the end, numbers used refer to engine position on plane; thus at 5,577 hr. the carburetor was changed on No. 3 engine.

that in all of Pan American's operating experience with Boeing 314's, only once has a wing been taken off. That was when the beginnings of stress corrosion in a main spar required that the member be replaced.

Because maintenance is keyed with a schedule of continuous operation, the various classifications of maintenance procedure comprise a combination of checks made on the basis of time limits and checks made according to when and how long the craft will be available over any series of stops.

Thus the first check is a sort of standard No. 1 check consisting of visual inspection of the aircraft performed pre-flight and also every two hours during flight.

Second subdivision is the overnight service done at a base or at any line station where the airplane may stay overnight. This service, which precedes all over-water hops, is performed for every 25 hr. of flight time. More detailed than No. 1, it includes a check list for both airplane and engine, to be initialed by the mechanic.

Third comes the "short engine service," prior to 75 hr. of operation, in which cowlings are removed and the power plants given a more careful check than any preceding.

Fourth is the main base service, prior to 250 hr. of operation, which includes a "long airplane service" and a "long engine service," as well as thorough inspection of equipment and cleaning of the interior, with removal of interior coverings. This check is followed by a test flight before resuming flying schedules.

But this is not all. With each main base service there is a set of variables which are taken in turn by rotation and by which a continual running check and overhaul process is maintained on the whole craft. In one base check the emphasis will be on the wings, with all heavy work required in this section done at this time, accompanied by inspection of the rest of the craft for any routine items that must be attended to. In the next base check, emphasis will be on the hull, with all possible work being done on this unit plus a routine check on wings. And in the following base check, the tail section will receive most attention, routine inspection being given the sections previously covered. In this way, the airplane can be kept in continually safe flying condition and still not be tied up more than 48 hr. at a time.

A system of this kind requires an accurate and efficient means of keeping track of each airplane's time, condition, and the progress of successive overhaul procedures. The over-all master record for each airplane is a running chart maintained by the company inspectors. As illustrated in Fig. 1, this gives a graphical bird's-eye view of all that has been done, with the craft's hours entered across the top in 25 hr. divisions and with all work performed marked below under the exact flight-time periods written within the 25 hr. groups. There is one of these for each airplane, and new sheets are added to the preceding ones throughout the ship's working life, which is just about indefinite.

Control of the individual base check is kept on large sectionalized side- and plan-view drawings of the aircraft. These are nailed up over the control desk accompanying each workstand; the latter being actually a drydock on wheels, completely surrounding the ship and containing nearly everything required for overhaul and service.

It is required that every section be checked, as marked out on the airplane charts, with particular attention to certain sections in rotation. Inspectors are assigned to various parts of the craft, and upon covering the whole plane, they assign all jobs to the various shop departments concerned. A separate sheet is given to each shop, with the work to be performed listed. From these, sheets, cards are made out for individual jobs for each man. Cards must be signed back, when work is completed, by both foreman and inspector. Space is provided for noting speed of work as well as quality of workmanship, so that a production efficiency check is maintained at the same time.

As each job is performed on the airplane and is approved by inspection, a red line is crossed through the proper section on the airplane chart.

In addition to routine procedures, the

(*Turn to page* 297)

ENGINE CHANGE

GROUP HULL SHOP INSTRUMENT

AM-42 - 4-39

PAN AMERICAN AIRWAYS SYSTEM

AIRPLANE EQUIPMENT RECORD

No. 1 AIRPLANE NC-_____

ITEM Tachometer Transmitter No Per AIRPLANE _____

TYPE _____ Model _____

Time Between Overhaul Hrs — Min 400 — Desired 500 — Max 600

Airplane Time Hours	328:41	349:55	343:41	134:17	173:32	208:44	430:35	463:07	467:19	578:57	579:11	595:16	633:13	659:00	667:11	694:31	744:16	753:41	808:45	845:11	848:11
Date Last Overhaul																					
6-3-39																					
12-6-39																					
1-5-40																					
6-6-40																					
8-1-40																					
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10-21-42																					
12-17-42																					
1-1-43																					
4-1-43																					
4-13-43																					
5-7-43.																					

NOTE ON REVERSE SIDE REASONS FOR DEVIATION FROM ROUTINE TIME PERIOD FOR REMOVAL OR OVERHAUL OF UNIT.

Fig. 2. This is the instrument record sheet. As each overhaul is completed, the date is entered at left and a line is crossed through square opposite, in proper airplane time column. By this cross reference any details may be had from shop which performed the overhaul.

HOW A NEW TYPE AIRPLANE TUBE SOLVED A BRAKE-HEAT PROBLEM

This is a cross section of the "U.S." Fabric Base Tube that solved the heat problem caused by excessive braking on the Cessna Bobcat Advanced Bomber Pilot Trainer. A reinforcing cord insert extending across the vital bead area increased 100 times the service life of the tube.

UNITED STATES RUBBER COMPANY

THE CESSNA BOBCAT BOMBER PILOT TRAINER

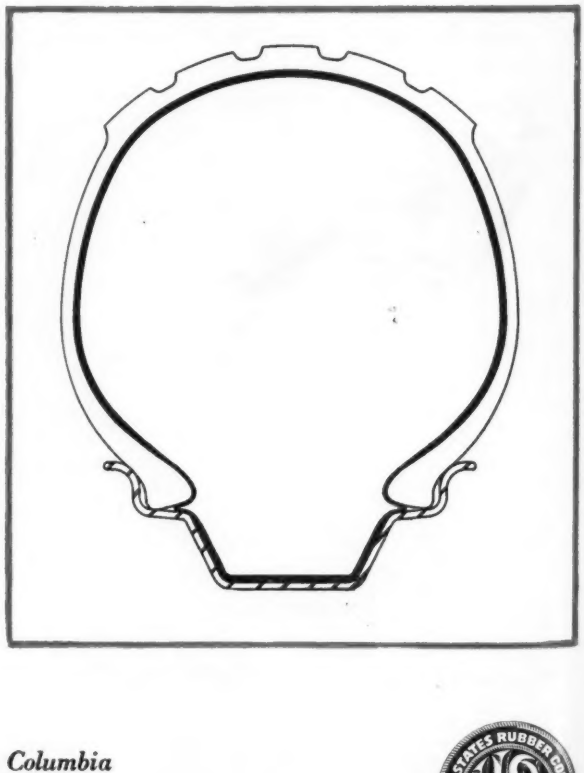
Cadets of the United States Army Air Forces fly this twin-engined advanced trainer before they take the controls of the Army's giant bombers. Like its namesake, the Cessna Bobcat is light and fast, giving the cadet his first thrill of fighting power in the air. But with this thrill, this feeling of speed, it was only natural for student pilots to use brakes excessively... and this caused overheating which made tubes fail, sometimes in less than five hours.

THIS WAS THE PROBLEM

It was natural for the cadet pilots at the controls of the Cessna Bobcat, coming in for landings at higher speeds than they had ever known before, to "tramp" on the brakes and keep them on continuously even while taxiing the plane. Temperatures as high as 750° Fahrenheit built up in no time... heats so high that no rubber tube, however good or however reinforced, could stand the gaff. Working with the brake manufacturer, Cessna engineers brought the temperature down to around 450 degrees. Performance improved, but still tube failures occurred far too frequently. That was the problem... an immediate answer had to be found.

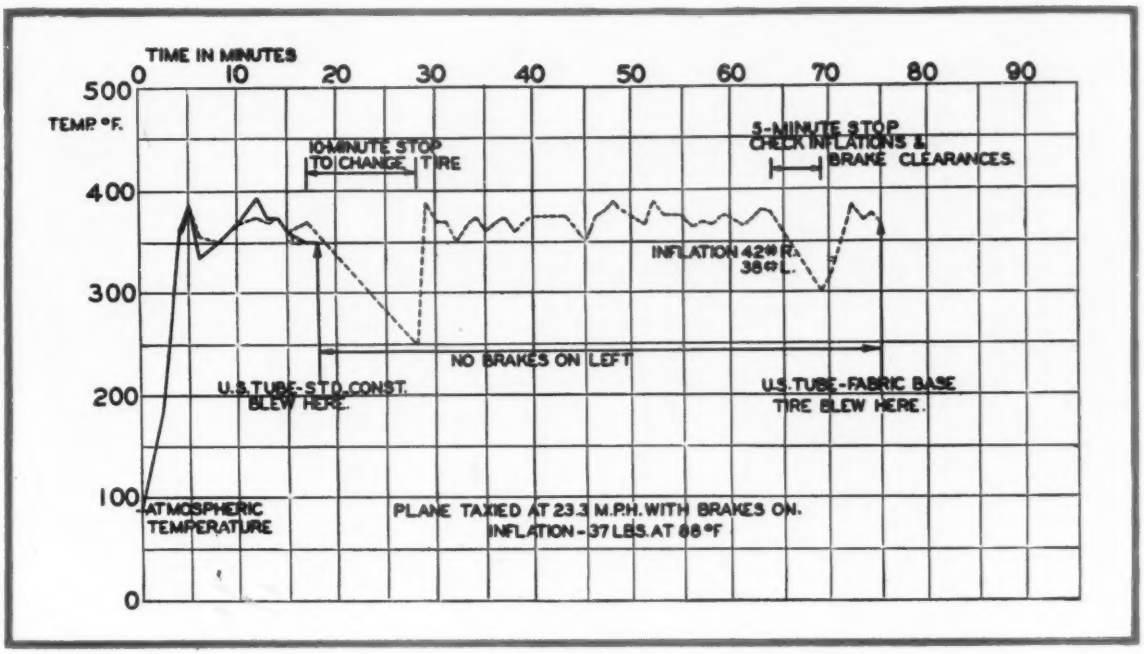
●

When an airplane tire rolls over the ground at high speeds, with as much as 35% deflection, the beads rock back and forth on the rim, stretching out the tube just above the toe of the bead. When the tube is cool, it remains elastic and snaps back into place without damage. But at high temperatures, the tube thins out, is stretched farther and farther and finally some of the weakened, thinned-out rubber is tucked in between the bead and the rim. The result is a "pinch"... and quick tube failure.



Listen to the New York Philharmonic Symphony broadcast over Columbia network every Sunday afternoon 3:00 to 4:30 P. M. Eastern War Time.

THIS IS THE ANSWER WORKED OUT BY CESSNA AND "U. S." FIELD AIRPLANE TIRE ENGINEERS



Jim Berry, one of the "U.S." Field Airplane Tire Engineers working with Cessna on the problem had a trick up his sleeve. Taking a leaf from his experience on bus lines where high brake-drum heats are frequently encountered, he suggested to Cessna that the "U.S." Fabric Base Tube might be the answer to this problem just as it had been the answer in the case of certain city-type buses.

Special tubes of this type were built and tested under the most severe conditions. In the test shown in this chart, a U. S. Royal Rayon Airplane Tire with a conventional construction U. S. Royal Tube was mounted on the left landing wheel of the Bobcat. On the right wheel a U. S. Royal Airplane Tire and Fabric Base Tube were mounted.

In five minutes of taxiing with brakes on, the temperature, checked by a pyrometer, was over 450°... and in 18 minutes the conventional tube blew out. They took ten minutes out to change the tire. Then, on with the test. The tire equipped with Fabric Base tube went on and on for 75 minutes with brakes applied until the casing failed because of carcass fatigue. The problem was solved—the proof of the pudding is that U. S. Royal Tires equipped with Fabric Base Tubes have been in service for 450 to 500 hours without failure...when before, tubes often failed in less than five hours.

Read what Cessna engineers said about the test: "It is concluded from this test that the Fabric Base Tube will outlast any casing under these conditions." If you are faced with a tube problem, the "U.S." Fabric Base Tube may be your answer. The services of a "U.S." Field Airplane Tire Engineer are available to test it on your aircraft.

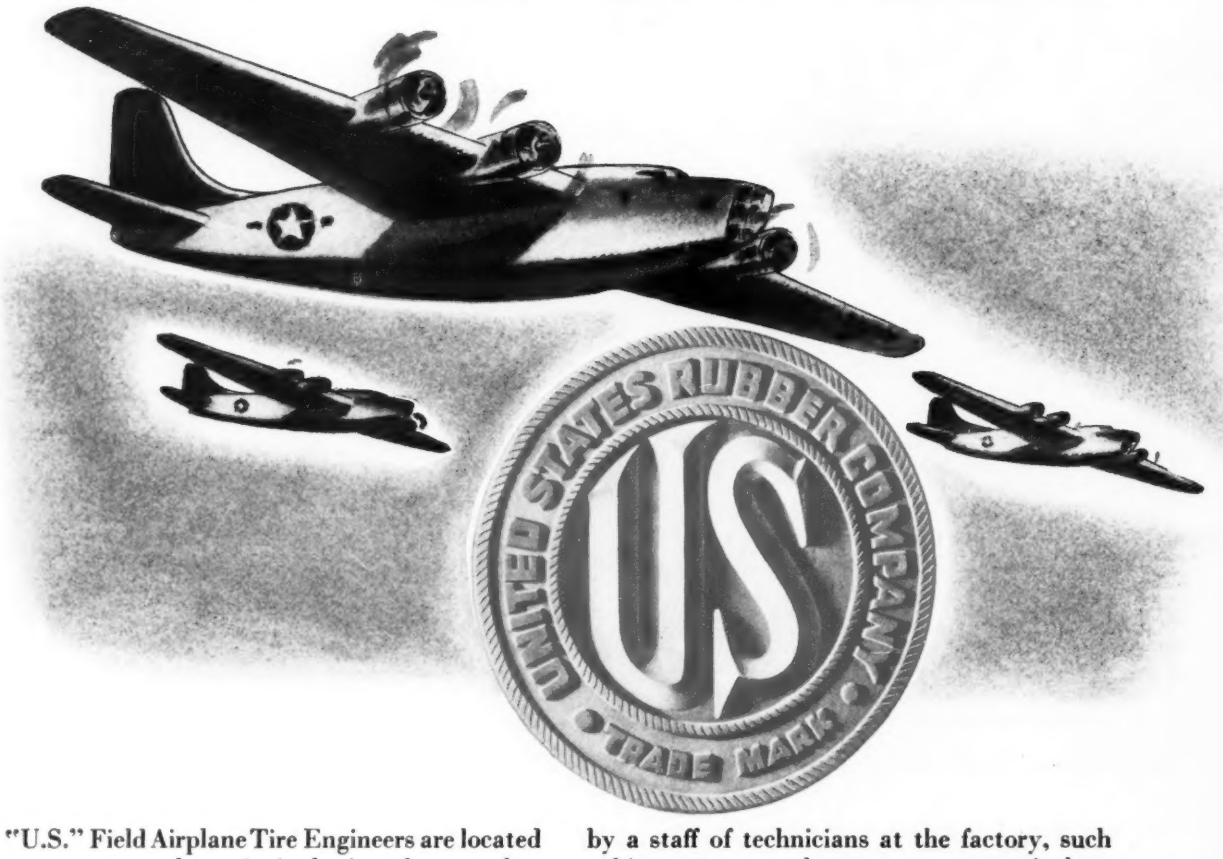
The way this problem was met and solved is not an isolated case. It is an example of the practical engineering service that "U.S." offers to the aircraft industry through its Field Airplane Tire Engineers.

J. G. Berry, "U.S." Field Airplane Tire Engineer, and A. E. Kangas, Cessna's Service Manager, inspect an installation of U. S. Royal Airplane Tires and Fabric Base Tubes. New Cessna Bobcats are now 100% "U.S." equipped on main landing gear.

UNITED STATES RUBBER COMPANY

1230 Sixth Avenue · Rockefeller Center · New York 20, N. Y.

How "U. S." Field Airplane Tire Engineers Can Help You With Your Tire Problems



"U.S." Field Airplane Tire Engineers are located at or near the principal aircraft manufacturing centers. Each of them is a graduate engineer. Each has had a generous background of high speed, heavy service tire and tube operation and now applies all of this training specifically to airplane tire and tube problems. Through this service, coordinated and assisted by a staff of technicians at the factory, such achievements as the rayon carcass airplane tire, Conductive Rubber, the Ice Grip tire, the Fabric Base Tube have all been developed. Each product advance has answered a specific problem in airplane tire engineering. As new problems are met, these "U.S." men are ready to help you find their solution.

This new book of Airplane Tire Facts is yours for the asking!

Just off the press, this 62-page book contains the latest technical data and engineering information on landing wheel, tail wheel and beaching gear tires and tubes. A series of 33 Load-Deflection Curves shows at a glance percentage deflection and deflection in inches at varying loads and pressures. A request on your firm letterhead will bring your copy without charge.

UNITED STATES RUBBER COMPANY

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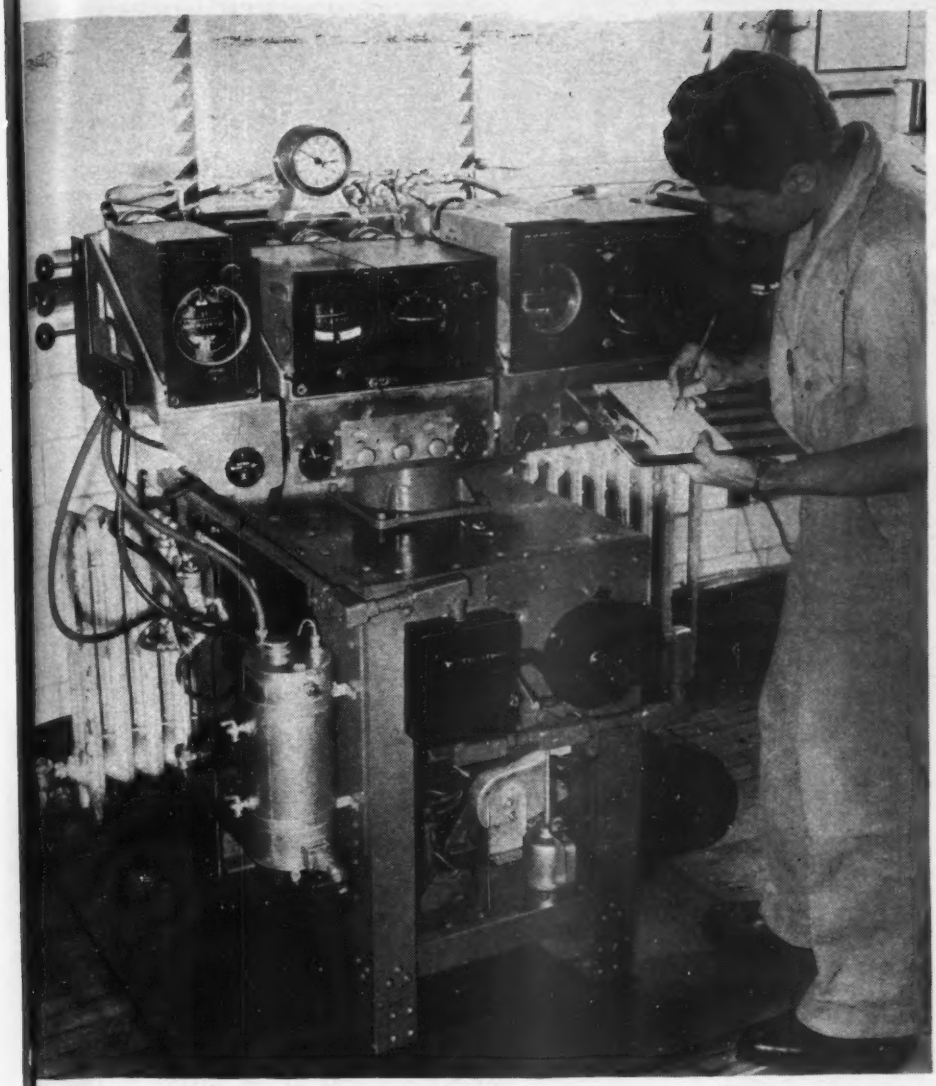
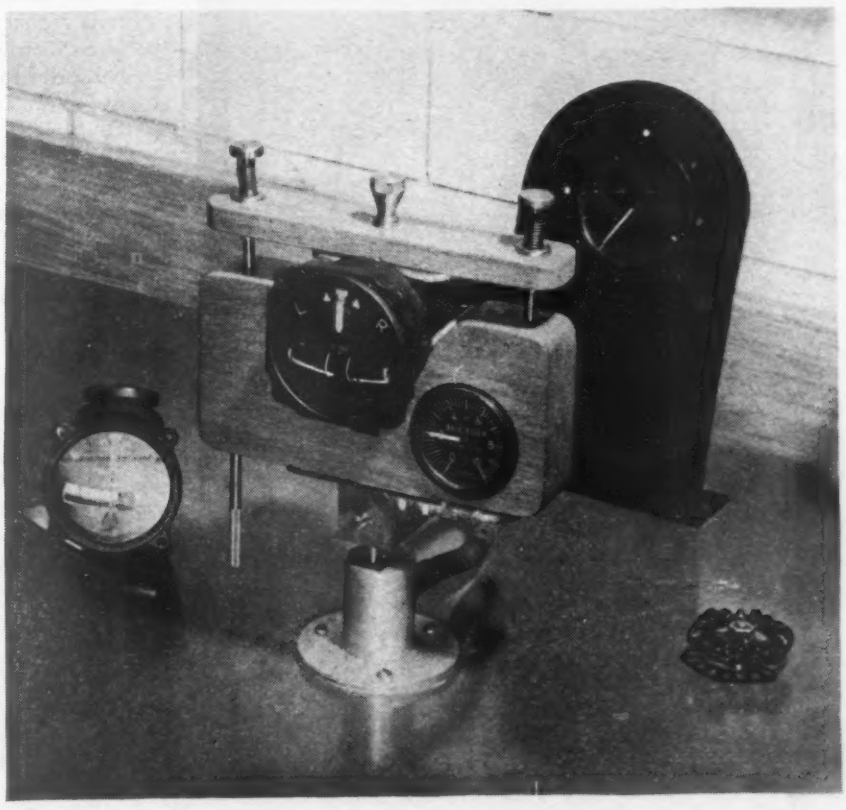


AVIATION'S MAINTENANCE NOTEBOOK

Scorsby Rebuilt by AA

• Entire top section of this Scorsby automatic-pilot check unit has been rebuilt by American Airlines, with lighter construction of wood. Where old stand accommodated only one A-2 unit, new version holds an A-2 and an A-3, with space at each end for directional gyros. Thus, four units can now be tested at one time.



merican Airlines rn & Bank Fixture

Nearly the same as original Pioneer unit, merican Airlines' shop has modified this rn bank indicator fixture to allow quicker stallation and removal of instruments to be ecked. Top clamp, instead of being fast- ed by a screw, is held down by springs on e bolts, holding padded wooden bar over rn bank indicator. To remove, it is only cessary to raise bar by center handle, then e next unit may be fitted. Checking opera- n of fixture is standard.

A NEW AVIATION GREASE... LOW-TEMP THAT WORKS AT... MINUS 100° F.

BASED on the belief that the stratosphere temperature was minus 67°F., Aviation greases were developed to lubricate critical airplane controls at or above this temperature.

However, recent test flights in the stratosphere recorded temperatures ranging between minus 80°F. and minus 90°F. and other tests registered still lower temperatures. The U. S. Weather Bureau has confirmed that temperatures lower than minus 67°F. exist in the upper air at all U. S. stations on practically all days.

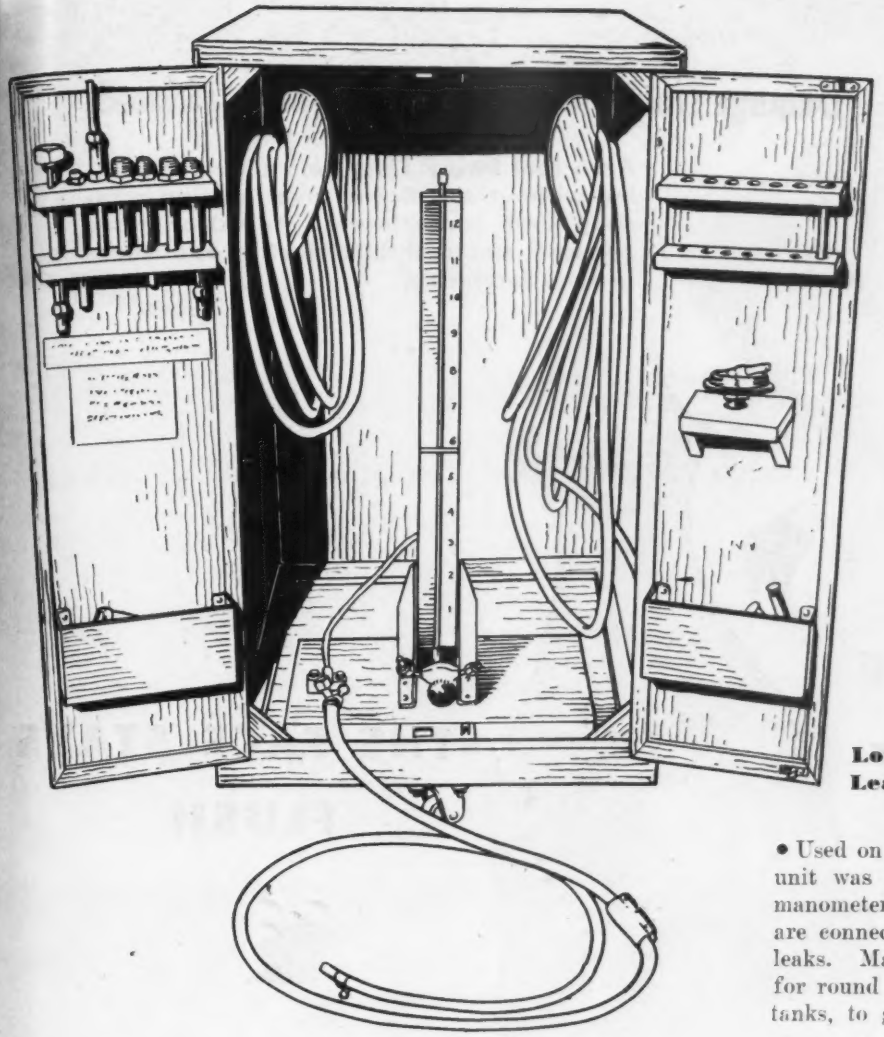
On these test flights, greases made for minus 67°F. temperature froze up when the stratosphere was reached. To correct this serious condition, Texaco developed a product which will permit all parts of the plane where it is used to function perfectly... *even at minus 100°F. This product is Texaco* **LOW-TEMP** *Grease.*

A Texaco Aviation Engineer will gladly cooperate in the solution of your low temperature problems. Phone the nearest of more than 2300 Texaco distributing points, or write The Texas Company, *Aviation Division,* 135 East 42nd Street, New York 17, New York.

TEXACO

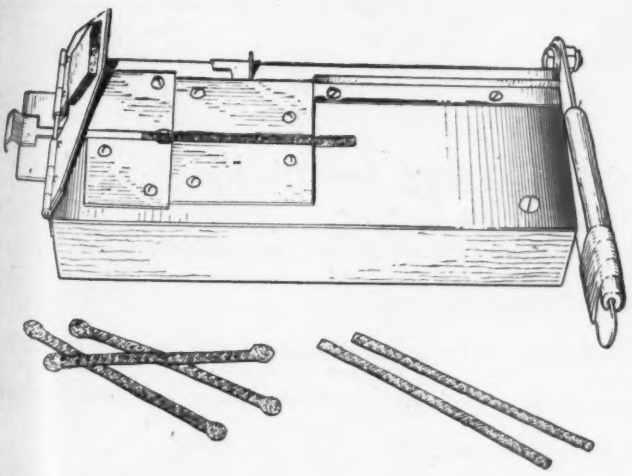
TEXACO LOW-TEMP GREASE

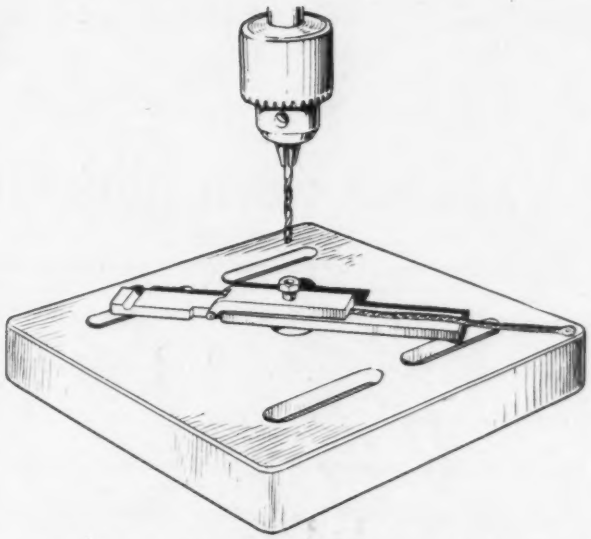
TUNE IN THE TEXACO STAR THEATRE EVERY SUNDAY NIGHT — CBS ★ HELP WIN THE WAR BY RETURNING EMPTY DRUMS PROMPTL



Low pressure Cabinet for Leak-Testing PAA Tanks

• Used on plant compressed air system at PAA, this unit was assembled by A. P. Peria from an HG manometer, a regulator valve, and air lines, which are connected to oil and fuel tanks to be tested for leaks. Manometer registers a maximum of 5 psi. for round tanks, is held down to 2 or 3 for square tanks, to guard against bulging flat sides.





Bonding Strip Manufacture at TCA

• This time saving device combines a cutter for bonding strips and a simple but very efficient means of upsetting ends for firm attachment. As shown (above) strip is inserted and hinged plate is held securely down over it by hand pressure on sponge rubber pad. Sliding plunger at left, which butts against bond strip, is struck sharply, causing end of bonding to be forced back and to expand into hexagonal hole provided for purpose. Travel of plunger is limited both ways, so that bonding end projects right distance beyond hole when inserted, and end is forced back just enough to fill space. Result is firmly matted ends of uniform size which will not unravel.

Second step in process (right) is jig drilling by means of drill fixture. Prepared end of bond strip is inserted into fitted space under drill guide, which accurately locates hole at center of matted end. Used together, these two inventions enable making of bondings accurately and in quantity. Credit goes to Roland Eades, radio shop, Winnipeg.

Damage from DINGING can be greatly reduced!
Aero Tool Swivel Flush Sets minimize dinging without sacrifice of rivet seating accuracy and smoothness. Rejections are reduced, speed of flush riveting operations greatly increased.
REGARDLESS OF THIS ANGLE—
-THE FACE STAYS FLUSH

Aero Tool SWIVEL FLUSH SETS Are Engineered for Green Hands

When these Sets are placed in the hands of unskilled labor better results are immediately noticeable, due to the broad angle of safety incorporated in their special design. They seat flush regardless of shank angle.

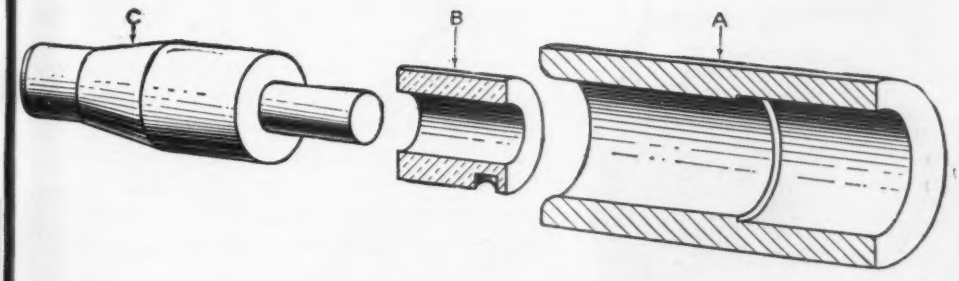
Typical Aero Tool precision design and manufacture are evident in all details of construction. Shank and Bell are of forged steel for great structural strength. Perfect fit between Ball and Socket prevents binding, assures perfect swivel action. Mirror-polished Full Crown Face eliminates excessive skin marking.

Cleaning and oiling are quickly done; the retainer collar is easily removed, the unit disassembled and re-assembled in a matter of seconds.

Write for catalog listing these and other Aero Tool Precision Products for better, faster riveting.

BLURPING IS NOT POLITE
...even for a rivet gun. Don't "blurp" a pneumatic rivet hammer when the rivet set is not in the gun—it causes immediate damage to piston and set bushing, takes valuable time to repair. Be careful—conserve tools!

AERO TOOL CO.
ENGINEERED AIRCRAFT TOOLS
231 West Olive Avenue, Burbank, Calif. • Department 000



Salvaging Die for Vacuum Pump Metering Collars

• Offered by Robert Holland at a Naval Air Station in Calif., device illustrated has been put to good use in reducing delay and expense in replacement of metering collars for Pesco vacuum pumps. Bronze collar (*B* in sketch) becomes worn by steel pin operating within it, causing increased clearance which allows passage of too much oil into pump. Hardened steel die *A* is ground to inside diameter .002 in. smaller than outside diameter of bronze collar *B*, and it is beveled at entrance to ease passage of collar. Latter is pressed through by means of fitted plunger *C*, shrinking collar down just enough to check oil passage to the amount required in overhaul specifications. Right hand section of die *A* is enough larger than left to allow easy extraction of processed collar. In actual practice, collar *B* varies ±.0015 in. o. d. due to wear, so that three sizes of steel die *A* are necessary.

Double-Purpose Scorsby at C & S

• Small bench Scorsby employed by Chicago & Southern has camming mechanism connected with rotating drive plate which actuates electric switch for automatic reversing after four turns in either direction. Same drive plate has a variable speed control and is also used for mounting and calibrating turn bank indicators.

America's New Source of
Aluminum · Ingot · Sheet
Extrusions · Wire · Rod
Bar · Forgings · Tubing
Foil · Powder · · · and
Finished Aircraft Parts

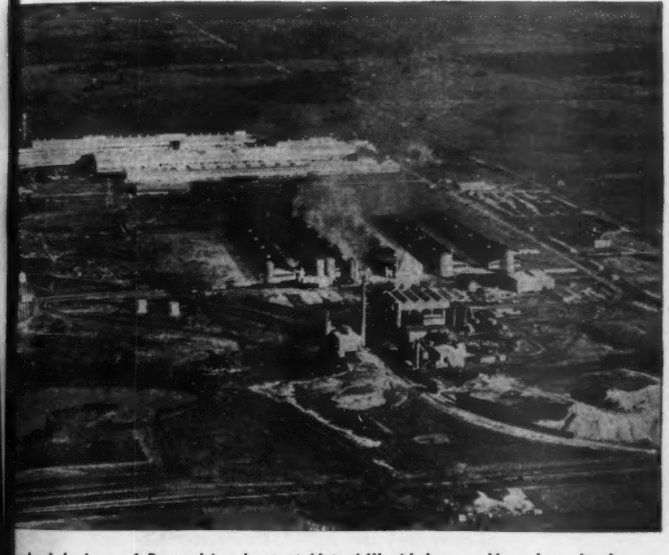
Shortening the steps from Bauxite to Bomber . . . Having built the first and only plant in the country where bauxite comes in at one end and aluminum sheet rolls out the other, Reynolds now carries the process still farther . . . making finished *aircraft parts* right at the aluminum source.

Since scrap from these parts averages 30%, Reynolds pre-fabrication saves aircraft manufacturers valuable storage space and labor . . . saves America precious shipping space and inevitable waste in handling. Reynolds turns out finished parts, quicker...and puts the scrap "back into the scrap" immediately.

For "flying aluminum," call for a Reynolds Sales Engineer . . . available throughout the United States.

REYNOLDS METALS COMPANY
PARTS DIVISION • LOUISVILLE • KENTUCKY
GENERAL OFFICES • RICHMOND • VIRGINIA
38 PLANTS IN 13 STATES

Reynolds Aluminum and finished airplane parts start in this Arkansas bauxite mine. Reynolds mines more bauxite per year than had ever been mined yearly before the war in the United States.



Aerial view of Reynolds plant at Listerhill, Alabama. Here bauxite is refined into alumina; the alumina is reduced into aluminum; and the aluminum is cast, alloyed and fabricated into sheet and rod.

Reynolds rolled aluminum alloy forging stock, tested and Army-Navy inspected, ready to be forged into aircraft propellers.

View of the Reynolds 300,000 sq. ft. expansion of the Parts Division in Louisville. New equipment includes giant 5,000 ton hydraulic press.

THE RISING CURVE OF SPEED!

UP at 40,000 feet...in the stratosphere ...the density of the air is only one-fifth of what it is at sea level.

That means lessened air resistance. More important, it means higher and higher speeds... *for planes built to go fast in the stratosphere.* Ordinary planes, though brilliant performers at lower levels, lose speed and maneuverability in the thin upper air.

The Republic Thunderbolt was built for the stratosphere... to speed at more than 400 miles an hour ... to out-dive, out-maneuver, and out-fight its rivals. With its 2,000 horsepower engine and its eight 50 calibre machine guns, it provides formidable protection for high-flying bombers.

The high stratosphere and sub-stratosphere levels have become the strategic levels of today's air war. Tomorrow, these levels will be the favored sky roads for high speed, long distance transportation.

In this sense, the Thunderbolt is a forerunner of the high-speed, peacetime air liners of tomorrow.

REPUBLIC *Aviation*

SPECIALISTS IN HIGH-SPEED AIRCRAFT

ARMY E NAVY
FARMINGDALE DIVISION

REPUBLIC P-47 THUNDERBOLT

BUILDING THE AAF
PART II

AT's Key Them for Combat

Having mastered his basic trainer, the student goes to Advanced—to get that first real taste of power and the "feel" of the fast fighters.

THOSE single-engine AT's are "warm" airplanes that condition Army Air Forces pilots for the "hot" ships they'll fly in combat.

When the cadet first meets the North American AT-6 he has mastered the low-wing basic trainer. He is now a pretty good flyer all primed to learn more. And the roar and pull of his new AT-6's 650 hp. engine give him intimations of experiences to come later in the fast fighters.

In 80 hr. aviation cadets master the AT-6 at Advanced flying schools scattered throughout the AAF Flying Training Command—at busy places like Napier Field in the heart of the Alabama "peanut country." Here a selected group of flying and administrative officers have been assembled for but one purpose: To make American boys combat-worthy in high-speed, maneuverable fighter craft.

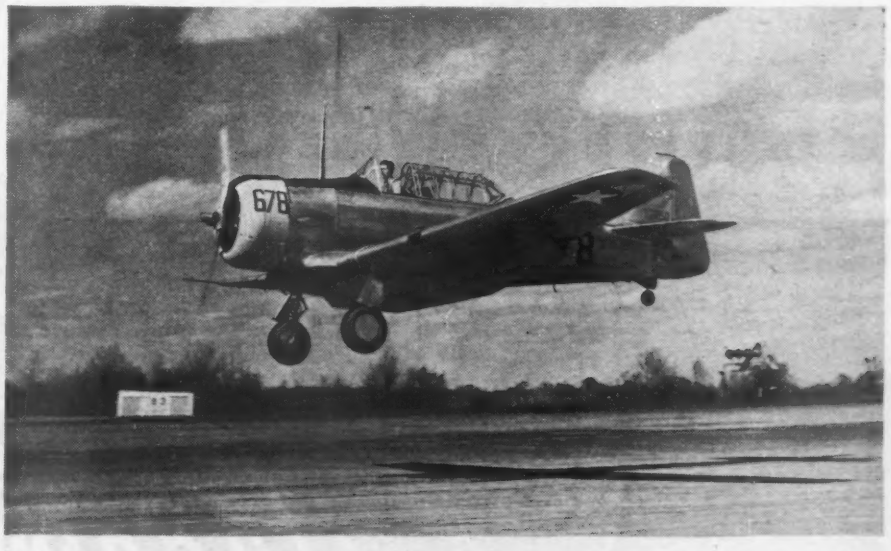
For more than 20 hr., the cadet at Napier familiarizes himself with day and night characteristics of this advanced trainer. With an instructor he "feels out" the ship in landings and takeoffs. He tries its flaps and he becomes acquainted with the landing gear controls, including emergency techniques for getting the wheels down in case of mechanical failure.

Hand-in-hand with learning in the air are lessons in ground school. The pilot of a single-engine plane must also be avigator, gunner, mechanic, and radioman. Aviation classes take the cadet a step further in the study of pilotage, dead reckoning, celestial and radio avigation. Avigation is emphasized in practice sessions in the Link trainer. And before he graduates, the cadet will have flown the AT-6 five hours on avigational flights. He will also have charted and flown a triangular contact avigation mission, followed beacons, light lines, and departed and returned to base at lower-than-usual altitude. After nearly 30 hr. flying time, the future pilot gets a chance to utilize his flying skill and avigational technique in cross-country hops with other students. A round-trip is usually approximately 350 mi.

When the fledgeling finally gets into combat, he'll probably fly in one of the two-plane formations that sally out to hunt the enemy. At Napier he practices close three-ship formations and later moves into two-ship tactical flights. Two of the hours devoted to aerobatics are concerned with combat maneuvers to inspire confidence and begin the lessons in out-feinting the enemy. The student also gets a chance to do a bit of legal "rat-racing" with one of his classmates. The two fly into a designated traffic-free area and then chase each other in a simulated dogfight. Although this combat rehearsal has the okay of officials, cadets are warned to check the

Southeast Air Corps Training Center Photos

Fresh from primary school, the cadet settles himself in a North American AT-6 to begin his 80 hr. advanced training. The instructor climbs in behind to guide him.



Among the aircraft devices which the cadet now learns to use are the flaps and retractible landing gear.

TESTED "IN ACTION" ON THE GROUND

for safer action in the air!

Not so long ago the only dependable way to check the operation of many parts of an airplane was to test them in action. And if tests had to be made in actual flight at the risk of a pilot's neck—well, in those days, what were test pilots for, anyway?

But HydrOILics has changed that.

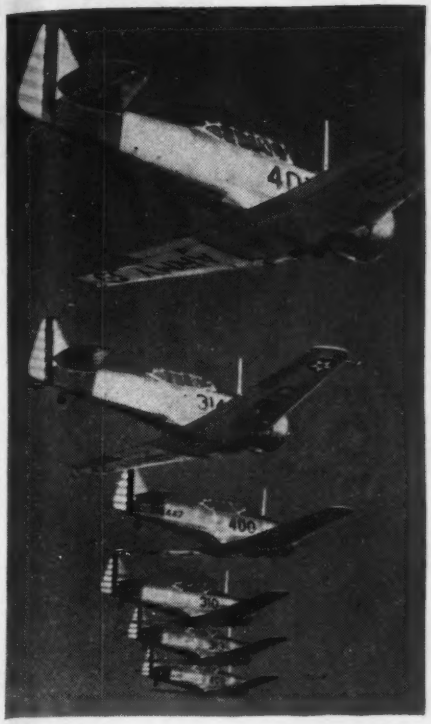
For example, the gasoline-powered HydrOILic Test Stand shown at right checks the whole hydraulic system of an airplane in a few short minutes—*while the plane is safe on solid ground.* It's a mighty important test because ailerons, rudders, brakes, bomb bay doors, landing gear, and even the propeller pitch of modern planes depend on the hydraulic system for safe, smooth, accurate operation.

Other HydrOILic Test Stands check other phases of airplane performance on the ground, for safety in the air.

Aircraft Testing Equipment is merely one of many ways in which Denison HydrOILic engineers have applied the numerous advantages of *oil-hydraulic operation.* The smooth, flexible, accuracy of HydrOILic's oil-transmitted POWER, SPEED and CONTROL has been adapted to an impressive range of operations in almost every industry. Have *you* sounded out the new possibilities for improving your product, or its production, with Denison HydrOILic engineering or equipment? For information, call your Denison representative, or write to Denison engineers.

The **DENISON ENGINEERING CO.**
1166 DUBLIN ROAD, COLUMBUS, OHIO

INDUSTRY'S NEW RIGHT HAND



Formation flights are primary in developing the student's "team" skill.

Time and distance problems are part of the avigation curriculum. Instructor (second from right) briefs students who will fly different routes to a rendezvous.

impulse to hedge-hop "just for the hell of it" or to curl up shingles on neighboring farm houses.

Between trips upstairs, Napier's student body is concerned with such important studies as aircraft and naval vessel identification, sending and receiving of code, and maintenance and operation of engines, instruments and controls. The cadet also marches, salutes, parades, shines, polishes, and scours. Although he's come a long way since the day he first reported to Pre-Flight, he still has to pay attention to such items as "hospital folds" on his bed, spots on his shirt, and scuffed-up toes on his shoes. Demerits are handed out for discrepancies, and if he amasses enough of them he spends his week-ends in his room and his spare hours trudging "punishment tours."

Training Is Varied

To be physically prepared for the often body-bruising experiences of combat flying, the student completes his flight training with a rigorous course in physical education.

Although he won't fire machine guns until he is assigned to Eglin Field, Fla., for eleven days of fixed gunnery training shortly before graduating, the advanced cadet whets his aim shattering clay pigeons on the skeet range. Here he meets the director of gunnery, a bullet-wise flyer who has completed the Eglin course and now supervises the introductory gunnery training period at Napier. Practice is given with the gunsight aiming point camera. Mounted on a bullet-less gun, it records the accuracy or lack of it in "dry runs" on a target. When the film is screened, the cadet and his instructor get a visual account of what was wrong with the shooting technique. The theory of aiming, firing, and range estimation is also taught at Napier.

After qualifying during his eleven days at Eglin's Fixed Gunnery School, the cadet returns to Napier. A percentage of each class is being graduated as non-commissioned flight officers and may later become second lieutenants, a rank given the remainder. But all of them get their wings.

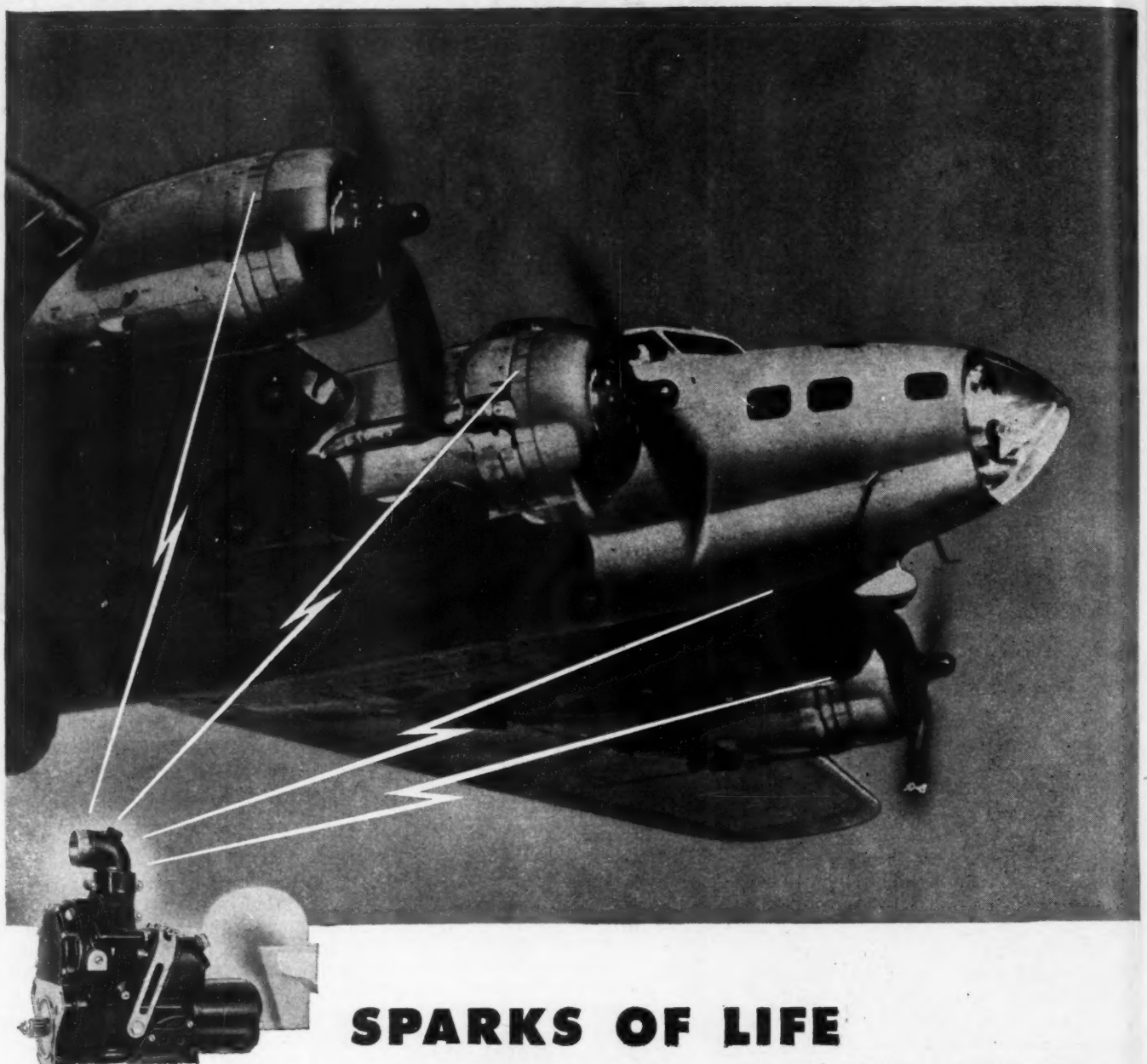
At many fields familiarization hops in combat planes are given advanced students before graduation. Here, instructor prepares cadet for his first trip in a P-40.

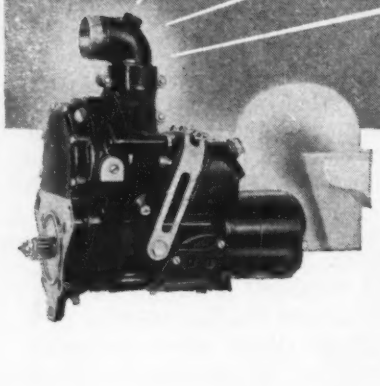
After Napier the new flyers are assigned for transition training to fighter, light or medium bombardment, observation or Air Transport Command planes, depending on the aptitudes and inclinations noted by their superiors during training. A select percentage become instructors.

Underway at many fields, and soon to be initiated at all Flying Training Command Advanced Schools, is a plan for the advanced aviation cadet to fly combat planes shortly before graduation.

Directing Napier's cadets is a group of experienced officers who have already won an enviable reputation for their relatively new training field. Col. James L. Daniel, Jr., the commanding officer, received his wings in 1924 at Brooks Field, Tex. Maj. Charles C. Simpson, Jr., is a 24-yr.-old pilot who knows all the answers about flying despite his youthfulness. The director of flying is another young executive, Maj. William A. McWhorter, 27.

In the words of Maj. S. R. McDaniell, Jr., Group 2 commander and 1940 graduate of Kelly Field: "We see them come and go—but we know these boys well. And we promise America that its Air Forces pilots are the kind whose presence out there where the going's tough can give us all a sense of confidence now and in the future. We should be grateful for their abilities and for their courage."





SPARKS OF LIFE
for the Queen of the Skies

HIGH out of reach of thundering enemy ack-ack, the Boeing Flying Fortress carries out her allotted task. One thing that enables her to fly at such high altitude is Bendix-Scintilla* Aircraft Ignition.

This precision-engineered equipment must generate, control and deliver *every minute* 40,000 sparks to each engine . . . timed to the split second! That calls for *precision* ignition . . . as engineered by Scintilla.

Engineering Bendix-Scintilla Aircraft Magnetos, Harnesses and Switches to their present high-altitude performance has constituted a series of major accomplishments in aircraft ignition design.

Today, these accomplishments are contributing importantly to the strength of wartime Air Power. Tomorrow, they will just as surely aid the progress of peacetime Air Transportation.

Bendix-Scintilla Aircraft Magnetos, Harnesses and Switches are vital members of "The Invisible Crew" — precision equipment which 25 Bendix plants from coast to coast are speeding to our fighting crews everywhere.

THE INVISIBLE CREW
Precision Equipment by
Bendix
AVIATION CORPORATION

*Trade Mark of Bendix Aviation Corporation.

SCINTILLA MAGNETO DIVISION BENDIX SCINTILLA THE WORLD'S FINEST AIRCRAFT IGNITION

OWI Lists CAP Accomplishments

"TODAY more planes are available for Civil Air Patrol assignment than the entire Army Air Corps possessed at the beginning of 1940," OWI says in a report revealing that since the week before Pearl Harbor when it was organized, CAP has enrolled 75,000 members drawn from the nation's aviation resources of 100,000 civilian pilots, with their 25,000 private planes and 2,000 civilian airfields.

Surveying the history of CAP with particular emphasis on coastal patrol, OWI lists 30 flyers killed, 24 of them hunting submarines, and a loss of 73 planes. "Fifty times, by record, CAP planes have scared off submarines about to torpedo or shell tankers," says OWI in paying tribute to the courage and resourcefulness of volunteers who spent their own money and risked their lives in the grim days of the spring of 1942, when "people stood on the beaches and watched the ships go down."

Of inland service, in which three men have been killed, OWI estimates that the growing courier service flies as much as 21,000 mi. per day in "a country-wide network of miniature airlines that have printed schedules of flights operated."

The services have absorbed 16,000 CAP members, according to the report, which says that while 3 percent of U. S. pilots are women, "CAP figures that some 10 percent of its membership is feminine." A Georgia squadron with 20 pilots among 50 members is composed entirely of women. Although they are paid for active duty assignments, members are estimated to be spending about $1,000,000 a month of their own money on emergency and practice flights.

CIVIL OPERATION AND TRAINING

On Patrol

• Enlisting cadets in the AAF is the most recent assignment for CAP units from National Commander Johnson in order GM-88. Members are asked to get in touch with prospective flying cadets between 18 and 26 and have them make applications at examining boards. Those who enlist in the reserve at 17 will be inducted six months after becoming 18; meanwhile they may wear a small wing pin on their civilian clothes. This recruiting program again emphasizes the value of the CAP cadet system as a pool for future pilots, bombardiers, and avigators. For instance, ten cadets enrolled in Minneapolis have been accepted by AAF. In order GM-84 Commander Johnson has also asked units to provide as much military training as possible to men about to be called to service.

The waters have subsided and CAP's record of assistance during the recent Midwest floods stands at a high mark. Two Arkansas squadrons of ten planes made 69 flights over 17,000 mi. during one two-week period. One member landed in the main street of a town to deliver telephone parts; another located a break in an eastbound 24-in. oil pipeline. In Indiana, Terre Haute Squadron 22 dropped bales of bagging (for sand) and other supplies to a marooned hospital. Visibility was a quarter of a mile and ceiling 400 ft.

Along the Apron

• An index to current safety memoranda has been issued as Release No. 146 by CAA. It supersedes No. 100.

Only one minor accident has occurred in 75,000 glider takeoffs and landings, according to *Glider Progress*, prepared by California Aero Glider Co., Los Angeles, which also describes pre-flight glider instruction being given in high schools. The company estimates that over 3,000,000 primary school students are building, repairing, and flying model planes.

Carrying out an idea of the late Eddie Allen, Boeing has stripped the armament and inside fixtures from a B-17, christened it *Bessie*, and sent it aloft as a classroom in specialized training for Second Air Force pilots. Chief lessons concern engine efficiency and operation in emergencies. For its factory training of mechanics who will serve as B-17 crew chiefs throughout the world, the company has received the Technical Training Command efficiency banner.

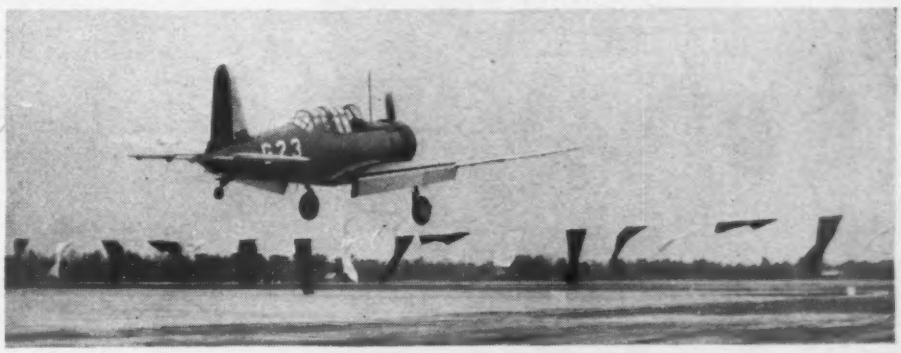
New courses in aviation law are being offered by Notre Dame University. Stewart Technical School, New York City, announces that its 960-hr., government-approved aircraft engine course is again open to civilians.

Scholarships and awards worth $5,000 have been given 77 engineering students in 33 colleges in a competition sponsored by the James F. Lincoln Arc Welding Foundation, Cleveland. A. F. Davis, vice-president and secretary of Lincoln Electric, has made a gift of a library of more than 700 books on welding to Ohio State University. The University also announces the establishment of a school of aeronautics and the addition of courses in aviation engineering and commerce.

Training courses covering AAF requirements have been inaugurated for instrument technicians by American School of Aircraft Instruments, Glendale, Calif. Curtiss-Wright Technical Institute, also of Glendale, is giving instruction for AAF mechanics and technicians under simulated field conditions.

First group of AAF pilots to be trained on the British flight syllabus—which eliminates basic training and adds 70 hr. advanced work—has been graduated from Southwest Airways' Falcon Field. Three more groups of Americans have begun studying with RAF candidates.

"Full status as members of the AAF on active duty will be accorded members of the Air Corps enlisted reserve who are selected to continue to receive pilot training under War Training Service," CAA announces.



"CLOTHESLINE" LANDINGS

To train pilots to land in small fields, AAF strings "clotheslines"—cords festooned with gaudy banners—across basic training fields. Students must clear them and drop to a stop in a 200-ft. stretch beyond. The lines are 10 ft. high and 100 ft. long.

Long before the war, American Export Airlines giant "Flying Aces" were equipped complete with radio transmitting, receiving and direction-finding equipment... designed and built by Bendix Radio.

Electronic Systems fo

1. ELECTRONIC TRAFFIC CONTROL
2. CREW'S INTERPHONE
3. TRANSMITTER-RECEIVER RADIO COMMUNICATION
4. ELECTRONIC BLIND LANDING SYSTEM
5. RADIO RANGE & AUXILIARY RECEIVER
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9. PASSENGER RADIO TELEPHONE
10. INTERPHONE MASTER CONTROL
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Engineering the complete RADIO ELECTRONIC SYSTEM is the business of BENDIX RADIO!

Vastly more than transmitters and receivers make up the radio-electronic system of a long-range bomber or transport. Even for pre-war airliners, Bendix Radio and airline engineers cooperated to design complete radio systems . . . custom-built.

Radio transmitters and receivers, interphone systems, remote indicating radio navigating installations . . . these and other complex electronic equipment comprise the signal corps of "The Invisible Crew." Designing and producing this whole network, with all necessary wiring, conduits and connections, is the business of Bendix Radio . ... now going forward on a vastly increased scale.

Back of these vital members of "The Invisible Crew" stand the specialized experience and pre-war "know-how" of Bendix Radio engineers . . . helping to make our fighting machines *The Vehicles of Victory*, and *The Transports of Tomorrow*.

Products of this division are vital members of "The Invisible Crew"—precision equipment which 25 Bendix plants from coast to coast are speeding to our fighting crews on world battle fronts.

THE INVISIBLE CREW
Precision Equipment by
Bendix
AVIATION CORPORATION

BENDIX RADIO **BENDIX RADIO DIVISION**

"Halifax II" Features Higher Speed

In Series 1a, a new nose, plus armament, engine, and fuselage changes give Britain's heavy Handley-Page bomber 10 percent greater efficiency.

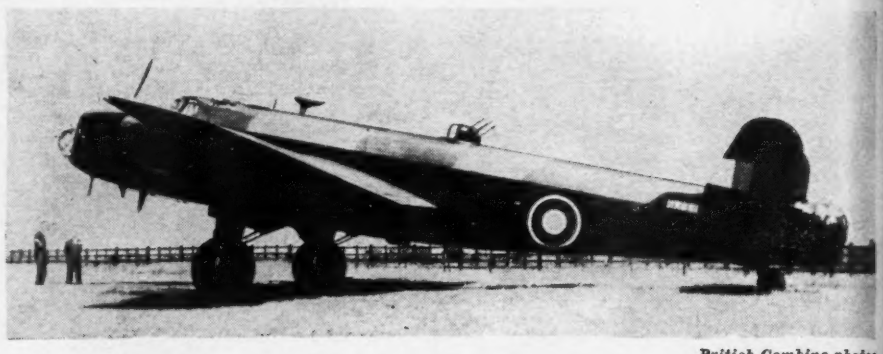
FLYING EQUIPMENT

EMERGING from extensive development and modifications as the Series 1a, the Handley-Page *Halifax II*, one of England's trio of four-engine heavy bombers, has gained approximately 10 percent in both maximum and cruising speed. Thus, on the basis of previously claimed top speed of 285 mph., the Series 1a today can do in the neighborhood of 315 mph.

This added efficiency has been achieved by a combination of engine change and extensive modifications to the fuselage and armament. Early *Halifaxes* were powered by Rolls Royce *Merlin 20's* which, in one stage of the transformation, were replaced by *Merlin 22's* and much more efficient exhaust stacks that added to speed.

Most noticeable fuselage change is the new nose, which looks very much like the type employed on late model Boeing B-17 *Flying Fortresses*. The original *Halifax* nose, it will be recalled, had a tight belt-in-the-middle profile due to installation of a two-gun power turret above the bombardier's compartment. Operational experience, however, proved that head-on attacks were rare, so the power turret was replaced by a smoother-contoured nose with horizontal transparent strips just above and below the center line and a large rounded transparent section below.

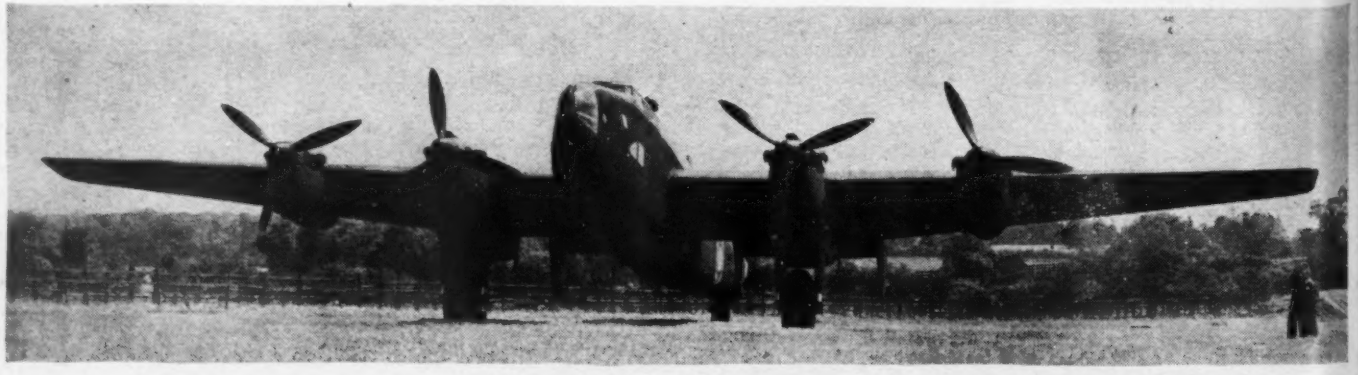
This arrangement, however, afforded no provision for gun installation so it, in turn, was succeeded by the present B-17-type nose in which is mounted a hand-operated Vickers *K* gun.



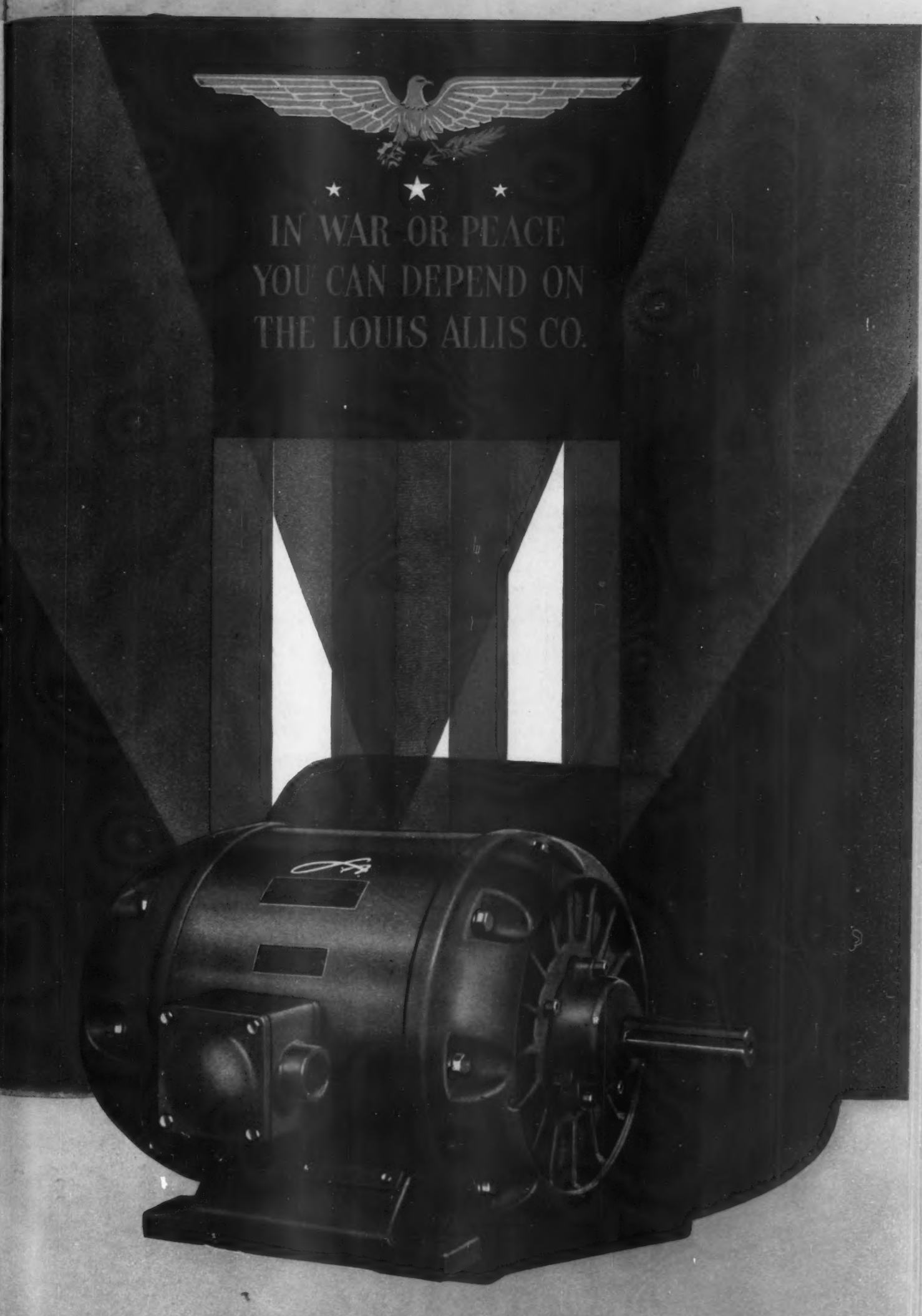
British Combine photos

Extensive modifications to Handley-Page *Halifax II* resulting in Series 1a (above) have comprised changes in fuselage and armament. Smoothly streamlined transparent nose greatly resembles type used on American-built Boeing B-17 *Flying Fortress*. Armed with a hand-operated Vickers gun, it replaces unusual twin nose of original *Halifax* (below) in which two-gun power turret was installed above bombardier's compartment. Top fuselage turret on Series 1a is four-gun type used on Boulton Paul *Defiant* fighter and permits greater speed.

Another important armament change has been made in the top fuselage turret. Originally the *Halifax* mounted a two-gun turret similar to that installed in the Lockheed *Hudson*, but during the transformation this was replaced by a four-gun turret of the type installed in the Boulton Paul *Defiant* (see p. 201 Sept. 1942 AVIATION). In addition to the added fire power, the Boulton Paul turret is said to contribute materially to the Series 1a's greater speed, since it sits much lower in the fuselage. (Also see p. 211 Aug. 1942 AVIATION.)



Newly designed nose coupled with Rolls Royce *Merlin 22* engines with improved exhaust stacks plus armament changes "up" maximum speed of Handley-Page *Halifax* Series 1a to neighborhood of 315 mph.



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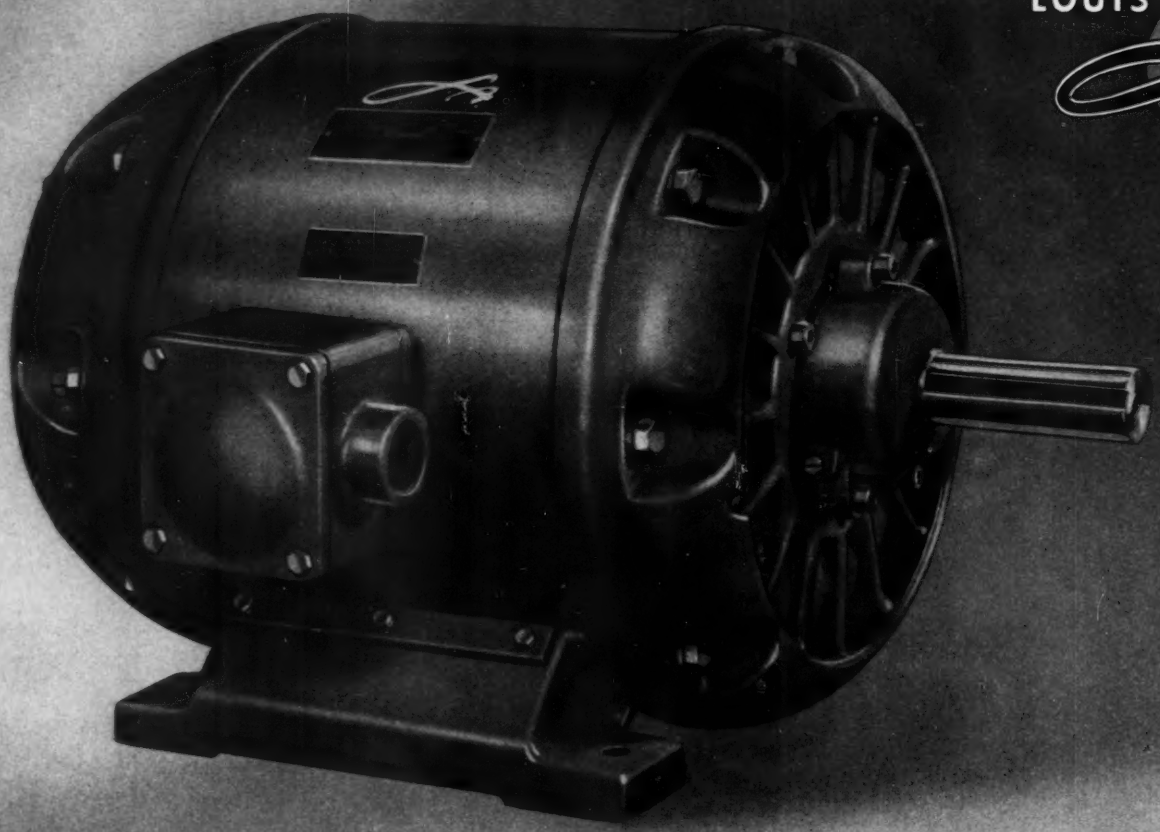

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As the originator — and pioneer — The Louis Allis Co. has more actual years of manufacturing experience with this type motor than any other manufacturer —

The present Louis Allis Explosion-Proof motor now makes available a new high in electric motor efficiency, dependability, convenience, long life and SAFETY!

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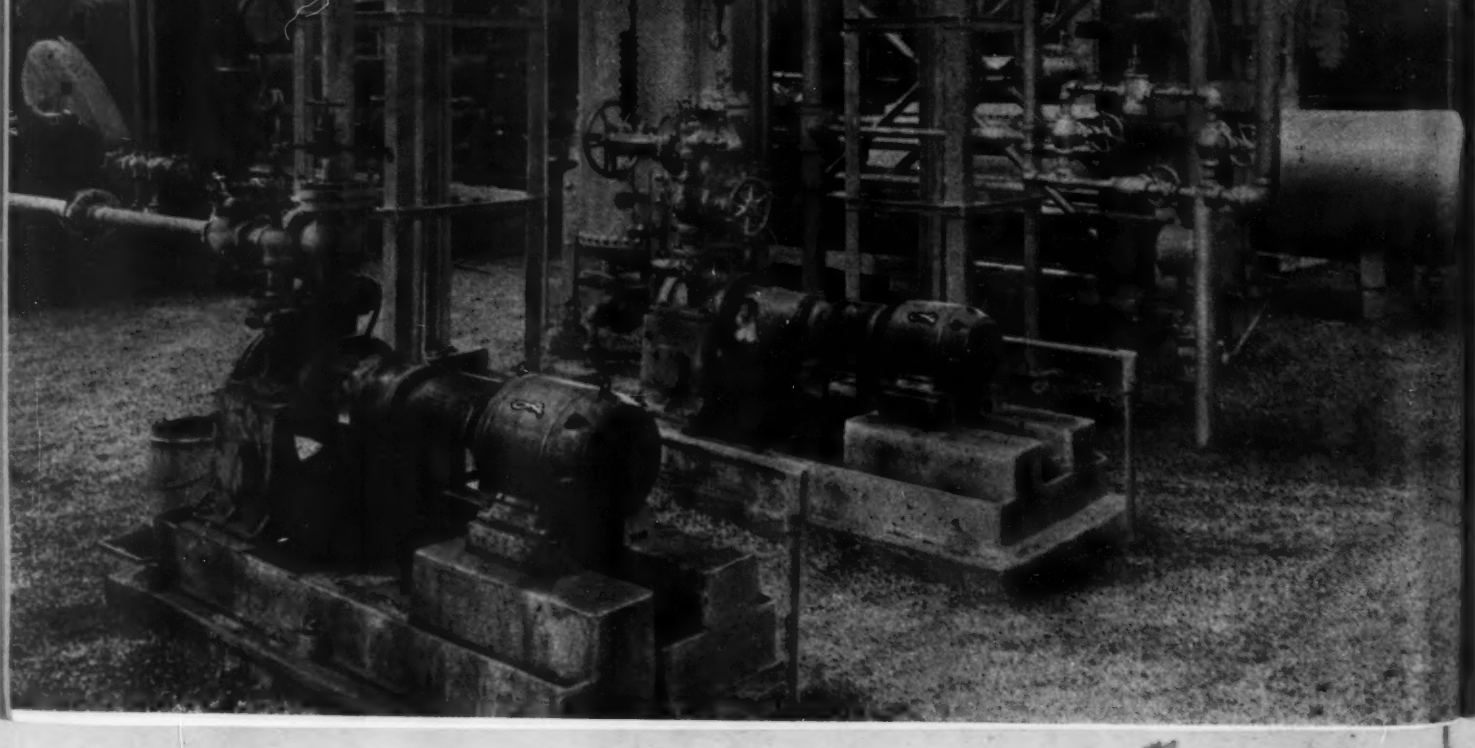

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Products & Practices

This selected information on new publications and products is offered by the "AVIATION" Reader's Service through cooperation with the manufacturers. It helps executives save invaluable time, provides profit through convenience. To obtain literature or additional data on new products described, simply fill in form below,* clip it to your letterhead, and mail. There is no cost, no obligation.

Re Carbide Dies.....1

Carboloy Co., Detroit, has made available three new bulletins. One, No. D-115, outlines a free training course in carbide die servicing available to workers in any mill using cemented carbide dies. The instruction calls for shop training periods. The company has also issued Technical Bulletins No. GT-157 and No. GT-158, the latter containing specifications, photographs, and descriptions of applications of a new chip breaker grinder and the former dealing with reclamation of carbide tipped cutters.

Dead Center Indicator.....2

Broadside from Atlantic Aviation Institute, Trenton, N. J., illustrates operating principle of its top dead center piston indicator for timing P & W and Wright engines.

Tapping Figures.....3

Guide for Production Tapping, booklet prepared by Cleveland Tapping Machine Co., Cleveland, gives figures on suggested tapping speeds for various materials, spindle speeds, lubricants, and drill sizes, also pictures and describes one of company's tappers.

Silver-Coating Process.....4

For use anywhere, equipment developed by Rapid Electroplating Process, Chicago, for silver-coating electrical apparatus and other materials is described in folder.

Abrasives Information.....5

Handbook covering the manufacture, storage, and uses of coated abrasives has been prepared for distributor salesmen by Behr-Manning, Troy, N. Y.

Flow Metering Data.....6

Catalog section 98-Y prepared by Fischer & Porter, Hatboro, Pa., contains technical data on the rotameter flow rate metering instrument. Among subjects covered are theory, capacities and correction factors, history, and accuracy analysis.

Electrical Catalog.....7

Indexed and illustrated 118-page catalog of electrical aircraft equipment made by more than 30 manufacturers has been compiled by Graybar Electric Co., New York City, which has organized an aviation department. Items are divided into four classifications: Wiring materials and motors, signaling materials, lighting equipment, and manufacturing tools. Locations of various company offices are given.

Employee Book.....8

Available for distribution among executives, employee handbook prepared by Lincoln Electric Co., Cleveland, describes the company's regulations, employee services, wage and suggestion systems, and workers' advisory board.

Buffing Materials.....9

Processes of buffing, burring, polishing, and lapping with compounds available from Formax Mfg. Co., Detroit, are illustrated in two bulletins from the company.

Jigs and Fixtures.....10

Herron-Zimmers Moulding Co., Detroit, has issued picture folder showing some of its jigs and fixtures available according to customers' blueprint specifications.

Phosphorescent Reproduction.....11

Services and delivery schedules maintained on phosphorescent process of lofting and template reproduction are available from Designers For Industry, Cleveland.

Machining Chart.....12

Calculating chart prepared by Crobalt, Inc., Ann Arbor, Mich., can be used to determine such figures as cutting speed, spindle rpm., in./min. feed, cutting time, and pieces produced per hour in various turning, drilling, boring, reaming, and other machine operations.

Hydraulic Control.....13

Sperry Products, Hoboken, N. J., shows in photos and drawings the specifications and possible installations of its single-tube, remote-control hydraulic controls described as having capacity up to 400 in./lb. and handle motion through 55 deg. without time lag or back-lash.

Socket Wrenches.....14

Suggestions on obtaining more service, speed, and safety from socket wrenches and prolonging life of small tools are illustrated in booklet prepared by Blackhawk Mfg. Co., Milwaukee.

Feed Fingers.....15

Loose-leaf sheet No. 114 distributed by Ampco Metal, Milwaukee, gives engineering data on company's non-scratching feed fingers for screw machines.

Midget Switches.....16

Acro Electric Co., Cleveland, has prepared new illustrated, loose-leaf catalog giving engineering data of ten types of various-purpose midget switches, one of them less than 1½ in. long and weighing less than 1 oz.

Cutting Oil Mixer.....17

Soluble Oils with Dresinate, folder published by Hercules Powder Co., Wilmington, Del., points out advantages and uses of this compound in the preparation of machine cutting oils.

Buyer's Guide.....18

Cutting tools, drills, reamers, abrasive

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AVIATION, 330 W. 42nd St., New York City

Please send me additional information according to key numbers circled.

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13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40	41	42	43	44				
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58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
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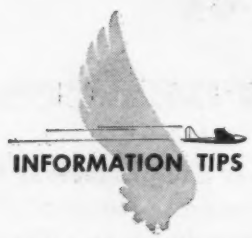


INFORMATION TIPS

wheels, rotary files, precision measuring tools and machines, and other critical equipment are listed in *Buyer's Guide* covering items of various manufacturers represented by Handley-Allen-Tapp Co., Kansas City, Mo.

Tool Movie.....19

Series of six talking movies on the *Use and Care of Hand Tools*, prepared by Plomb Tool Co., Los Angeles, under supervision of Army Ordnance Dept., is being made available to industrial and vocational schools at cost.

Electronics Explanations.....20

Material on electronics, prepared by Westinghouse Electric & Mfg. Co., East Pittsburgh, includes two non-technical pamphlets, *Electronics at Work* and *The ABC of Electronics at Work*, and a motion picture, loaned free to war plants, explaining the uses and six basic functions of electronic tubes.

Porous Bearings.....21

Keystone Carbon Co., St. Marys, Pa., is placing on its mailing list names of engineers and production executives wishing to receive periodic lists of stocks of its self-lubricating porous bronze bearings available for immediate delivery. Designed to require no reaming, bearings have tolerances of —.001 in. o.d. and i.d. per in. and ±.005 in. per in. of length.

Tool Care.....22

Tool Conservation Begins in the Tool Crib, profusely illustrated bulletin of Greenfield Tap & Die Corp., Greenfield, Mass., shows various recommended shop storage practices for increasing life of tools.

Welding Recommendations.....23

Text and two charts of data in folder issued by American Welding Society, 33 W. 39th St., New York City, on *Spot and Seam Welding of Low Carbon Steel* are designed to furnish recommended practice information meeting Army and Navy requirements. Price 10c.

Electrical Charts.....24

Wall charts drawn up by Ohmite Mfg. Co., Chicago, are available on Ohm's law for determining other current measurements and calculating resistance in resistors wired in parallel.

Bearing Data.....25

Booklets recently issued through The Torrington Co., Torrington, Conn., are *Engineering Revisions Applicable to Needle Rollers*, *Needle Bearings* and *The Bearing Engineer*. Featured are articles on double-direction roller thrust bearings and the use and designations of needle bearings.

Cutting Oil.....26

Announcement of special type cutting oil designed to provide an oil film on tools used on hard alloy steels is made by Basic Oils Co., Los Angeles, which has prepared descriptions of the lubricant's qualities, uses, and ingredients.

Storage Battery Life.....27

Suggestions on prolonging life of storage batteries have been listed in leaflet issued by Gould Storage Battery Corp., Depew, N. Y.

Wire Markers.....28

Machines for indentification marking of electric circuit wires, now required every 3 in. in wiring used on aircraft, are shown in folder and broadsides from Markem Machine Co., Keene, N. H.

Propeller Checker.....29

Lombard Governor Corp., Ashland, Mass., illustrates in broadside its propeller protractor and checking plate for obtaining minutes and degrees of relative blade pitch after assembly from one setting and at several stations.

Design Strengthening.....30

Method of strengthening sheets and strips of carbon, alloy, and stainless steels, aluminum alloys, and other nonferrous materials by imposing webbed and corrugated patterns is illustrated in booklet from Rigid-Tex Corp., Buffalo, N. Y. Test data and application information are also included.

Miniature Bearings.....31

Folder prepared by Miniature Precision Bearings, Keene, N. H., gives specifications and various applications of radial and pivot ball bearings available in sizes of $\frac{1}{8}$ to $\frac{5}{16}$ in. o.d.

Wheel Dressers, Cutters.....32

Calder Mfg. Co., Lancaster, Pa., has issued catalog folder No. 38 illustrating its various types of grinding wheel dressers and cutters.

Tool Handbook.....33

Featured in 48-page handbook on tool steels made by Copperweld Steel Co., Warren, Ohio, are a chart listing more than 70 tool applications, recommended choices of steel for them, and a section of tables on fractions and decimal equivalents, hardness, Fahrenheit-centigrade conversions, and symbols of chemical elements.

Welding Charts.....34

Victor Equipment Co., San Francisco, is distributing tabular charts on welding and burning giving information on metal thicknesses, tip and drill sizes, oxygen and gas pressure, cutting speeds, and length of flame cone.

Angle Computer.....35

Features of an angle computer said to simplify and shorten layout of die work, surveying of castings, and inspection of precision machined parts are illustrated in folder published by The Angle Computer Co., Los Angeles.

Glossmeter.....36

For measuring gloss from 0 to 100 percent on any plane surface at angles up to 70 deg., American Instrument Co., Silver Spring, Md., is manufacturing a glossmeter which is described in folder from the company.

Beading, Marking.....37

Two folders distributed by The Parker Appliance Co., Cleveland, show the firm's equipment for beading aircraft tubing according to AN specifications and marking bars and rods.

Electric Controls.....38

Condensed Catalog No. 1 prepared by R. W. Cramer Co., Centerbrook, Conn., contains illustrated descriptions of the company's automatic electric timers, time delay relays, running time meters, and signal control switches.

Management Suggestions.....39

Six booklets written by Glenn Gardiner and published in the interest of better management by Elliott Service Co., 210 E 44th St., New York City, are entitled *How to Cut Waste*, *How to Train Workers Quickly*, *How to Correct Workers*, *How to Handle Grievances*, *How to Create Job Satisfaction*, and *Qualities of a Good Boss*. Prices range from 30 to 45c., lower in quantities.

Turret Lathes.....40

Two series of turret lathes manufactured by South Bend Lathe Works, South Bend, Ind., with respective saddle swings and swings over beds of 9¼ and 10½ in. and collet capacities of ½ and 1 in. are shown in detail in company Catalog No. 901.

Cowl Fasteners.....41

Catalog available from Camloc Fastener Corp., New York City, shows addition of floating cam collar allowing large spotting tolerances to firm's line of cowl fasteners. Adaptable to metal, plastics, and plywood, new device, like rest of firm's line, is reported usable with both slotted and wing head stud assemblies of the same series.

Welding Chart.....42

Eutectic Welding Alloys Co., New York City, has compiled chart listing the physical properties and various procedures in the use of its Castolin alloys in the welding of various materials.

Training Films.....43

List of worker training movies produced by U. S. Office of Education on machine shop work involving engine lathes, precision measurement, drills, milling machines, etc., can be obtained from Castle Films, New York City.

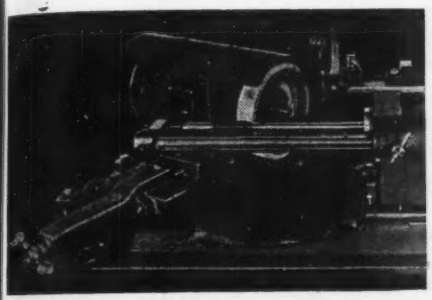
Abrasive Wheels.....44

Folder from Flex-Abrasive Co., Chicago, gives pictures and sizes of wheels and points for use on alloy steels, wood, plastics, and rubber. Patented construction feature is reported to keep fresh abrasive surface constantly in contact with the materials.

Latest Machine Tools

Tap Grinder 45

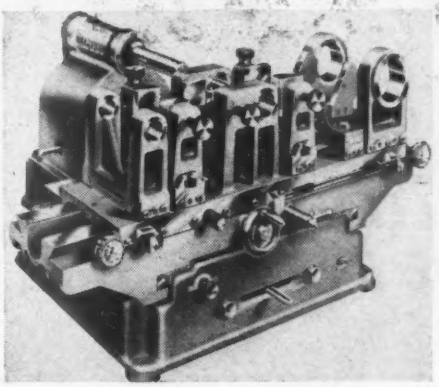
Feature of tap grinder illustrated is segment under wheel head slide wide enough to allow head to be swivelled for chamfer angle in back of work. Similar to No. 1 grinder this model, No. 2 made by **Edward Blake Co.**, Newton Centre, Mass., has longer bed for taps up to 14 in. and longer feed screw for clearing bed when wheel head is swung to extreme rear position. Change gears are provided for sharpening 2, 3, 4, 5, 6, 8, or



10 flutes right- or left-hand. Taps can be held in bushings manufactured by the company, in collets, or between centers. —AVIATION, *Sept.*, '43.

Portable Rod Borer..... 46

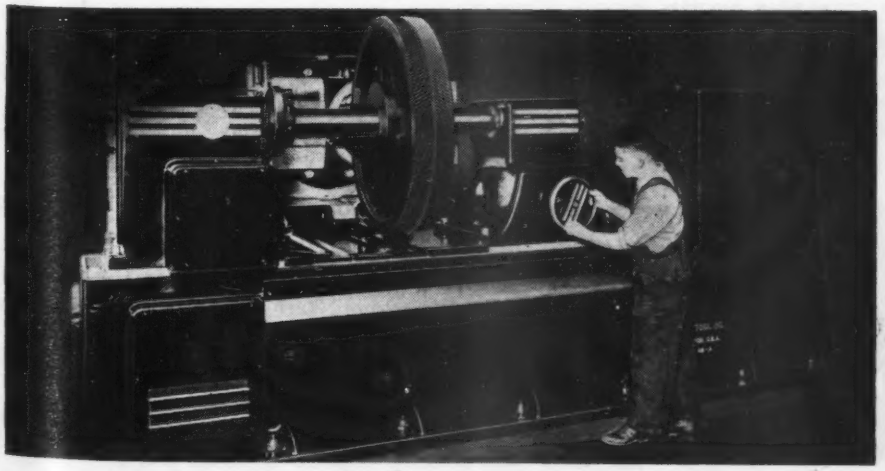
New connecting rod boring machine light enough for easy transport yet maintaining the close tolerances required in factory specifications has been introduced by **Century Engineering Co.**, Los Angeles. Simple to operate, new machine is suitable for all types of repair stations and can be taken into the field, as it requires only a single 110-v. connection and one air hose for operation. Rigid base casting is suspended on three feet to prevent distortion, so machine need not be leveled. Part to be bored is fed into boring bar with a hydro-pneumatic feed. Space bars for specific rod are used to set rod centers. Rod is then placed in position on two mandrels and held until self-centering and self-equalizing clamps are tightened. These clamps prevent stress on rod. Mandrels are then removed and first hole is bored. Without moving part, entire fixture is moved to second position by means of a handwheel, which operates cross slide, and is checked with a dial indicator. Second hole is then bored. As rod is not released until both ends are bored, holes are parallel, with no possibility of misalignment to an extra set-up. Machine



and equipment is packed in a heavy wood container for field use.—AVIATION, *Sept.*, '43.

Gear Finisher 47

Said to be the largest standard crossed-gear shaver in use today, machine illustrated was made by **Michigan**



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THE powerful levers instantly pull the jaws together and hold the work in a grip that is far beyond any pressure exerted by the ordinary crank operated vise.

Precision Adjustment

When the jaws of a FENN come together they take hold uniformly. This can be demonstrated by clamping two pieces of paper — .001 of an inch in thickness — one at each end of the jaws.

Proven Performance

This Quick Action Vise has been in use for 25 years. Believe it or not, in all that time we have never had a complaint as to its workmanship or performance, and we have had unstinted praise from many users.

Three sizes: 4" — 5" — 7"

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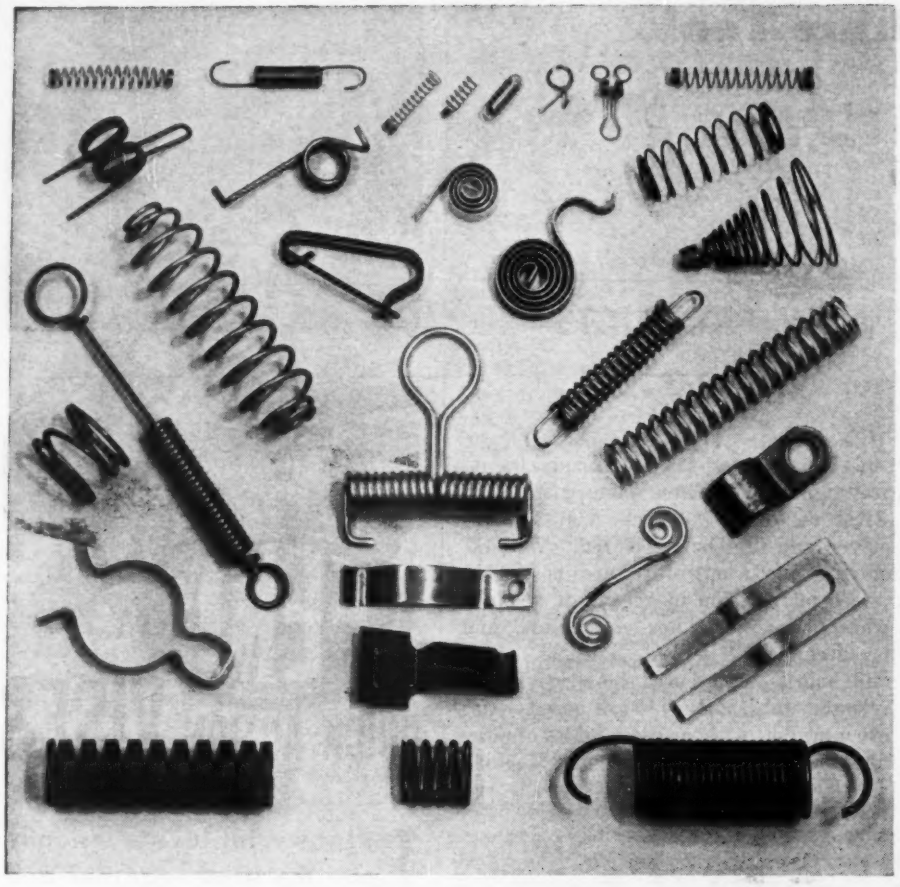

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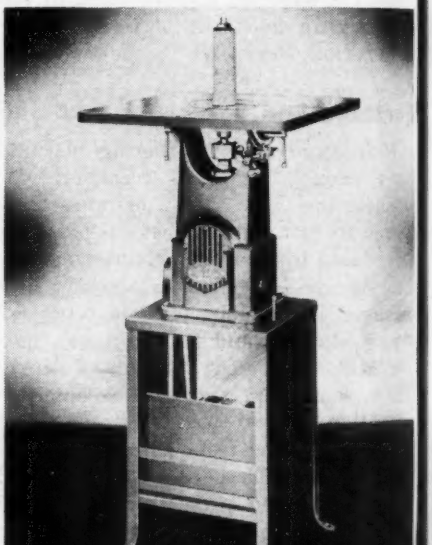
NEW PRODUCTS

Tool Co., Detroit, for a Milwaukee company, which has used it to finish more than 100 types of gears from 4 in. to 4 ft. in dia. and 12 in. face with diametral pitch range of 3 to 10.—AVIATION, *Sept.*, '43.

Spindle Sander..... 48

Oscillating portable spindle sander offered by **Boice-Crane Co.**, Toledo, can produce any degree of bevel on aluminum, masonite, brass, die castings, and template sheet iron up to 6 in. across. It is reported that machine can sand faces which blend gradually through different slopes at successive cross-sections. Oscillating automatically through a $\frac{7}{8}$ in. stroke, the sander completes 83 strokes a minute at 2,500 rpm. Square



table, 20x20 in., tilts 45 deg. in either direction, and two index lines show positions for beveling, drafting patterns, and core-box work. Other standard equipment includes $\frac{3}{4}$ and 2 in. nesting rings, dust- and leak-proof crankcase and bearings sealed in grease at factory. —AVIATION, *Sept.*, '43.

Hydraulic Press..... 49

One-ton line of "Junior" hydraulic bench presses of **Colonial Broach Co.**, Detroit, are now available in floor models, making them applicable to pull-down broaching operations. Puller mechanism is located in base as is coolant tank and coolant pump driven by an integral motor. Both bench and

This is Synthetic Rubber

Synthetic rubber is a new basic raw material which is processed, treated and formed in much the same way as natural rubber. And...like natural rubber...it is of different types, is capable of many variations.

Synthetic rubber is manufactured from gasoline, alcohol, coal and gases kept liquid under pressure and is now being made in five basic commercial types. Each type has distinct properties and characteristics that fit it for specific tasks. For some, synthetic rubber is superior to natural rubber. For others it is equally as good.

To determine which synthetic rubber is right for the job, however, requires a really thorough knowledge of rubber chemistry. The manufacturer must be familiar with the properties of all five commercial types . . . Buna-S, Buna-N, Neoprene, Thiokol and Butyl.

United States Rubber Company uses all five basic types of synthetic rubber and is thoroughly familiar with the characteristics, properties and suitability of each type to the task for which it is intended. As the nation's largest user of synthetic rubber, "U.S." has built up a tremendous backlog of knowledge of this new basic raw material and experience in processing synthetic rubber to handle a certain definite job. Today, this knowledge and experience are being drawn upon to the fullest in supplying the Armed Forces and war industries with the synthetic rubber and synthetic rubber products they need.

A copy of "The Five Commercial Types of Synthetic Rubber" will be a valuable addition to your files.

Listen to the Philharmonic Symphony program over the CBS network Sunday afternoon, 3:00 to 4:30 E.W.T. Carl Van Doren and a guest star present an interlude of historical significance.

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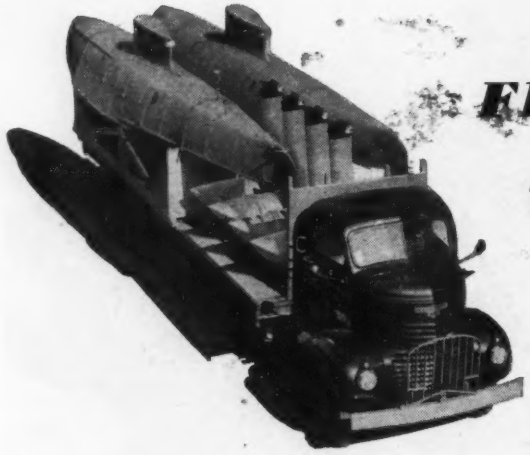

FROM COLLEGE POINT . .
TO THE SEVEN SEAS

Edo seaplane floats move in ever-increasing volume

Special trucks, carrying two complete seaplane float installations including wing tip floats, roll out through Edo's plant gates with time-table regularity.

18 years of "know-how" in the design and manufacture of all-metal seaplane float gear account for the ability of the Edo organization to maintain production schedules that meet the needs of a global war. Particularly, does this specialized experience count for exceptional performance in Primary Erection where highly skilled and trained craftsmen assemble the float structures—first bolting the bulkheads to the cross arms of multiple assembly jigs; then riveting the longitudinal members to the bulkheads; next riveting side and bottom sheets in place and making the floats ready for decking, water-testing, etc.

Modern, up-to-date tooling and processing technique providing accurate interchangeable parts for rapid mass production of assembly, contribute vitally to speed in the output of the Primary Erection department where Edo floats first take form. But experience is the prime factor in building a product of uniform quality in large volume—so that the "world's finest seaplane floats" may move in ever-increasing quantities to ramp, beach and catapult deck . . . to every operational point of our far-ranging seaplane squadrons.

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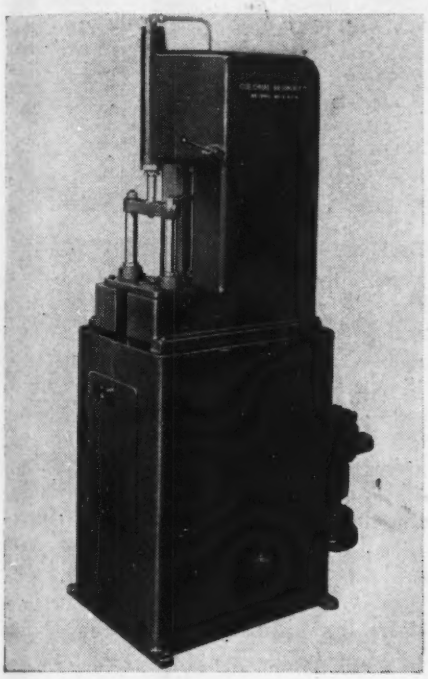
SERVES THE UNITED NATIONS

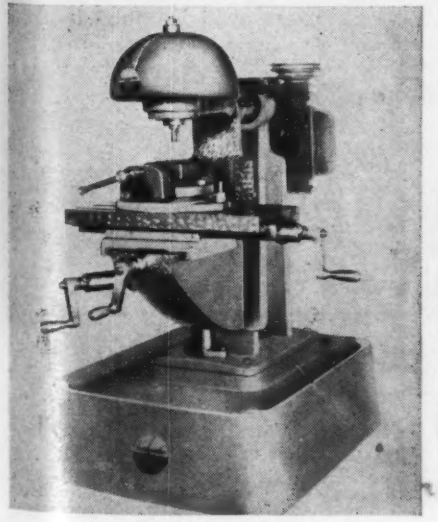
base models are also available without coolant system for assembly operations. These Junior models are said to differ from larger Colonial presses chiefly in



size and capacity. Hydraulic fluid pumps and reservoir are contained in main press body. Downward ram speed is given as 30 ft./min. and return as 60 ft./min. Stroke is adjustable up to 12 in.—AVIATION, *Sept.*, '43.

Miller Attachment 50

An attachment for horizontal milling in announced by **Benchmaster Tool Co.** (formerly Duro Mfg. Co.), Los Angeles, as a feature of its improved vertical



STEADY PERFORMANCE

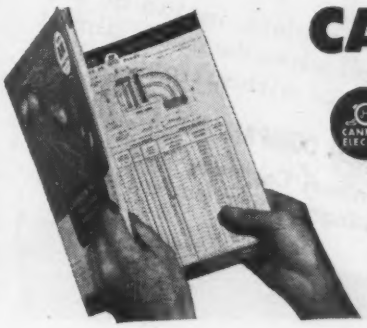
...AT ALL POINTS OF HIGH VIBRATION

This special vibration-proof Cannon Connector, because of its precision-built unit construction, is highly desirable for use on equipment which is subject to excessive vibration ... such as the feathering governor, mounted behind the propeller.

The special type of Cannon Connector developed for use in this exposed position retains the coupling ring on the fitting by means of a phosphor bronze retaining ring designed in such a manner that permanency is assured. The barrel and the major portion of the shell are cast in one piece in order to withstand vibration.

This connector is just one of the many thousands of types made by Cannon for connecting and disconnecting electrical circuits quickly and with absolute certainty.

The Bulletin on Cannon Type AN Connectors ... gives a complete explanation of construction and operation of AN plugs. 82 pages with ample illustrations. Address Dept. A-110, Cannon Electric Development Co., Los Angeles 31, Calif.



CANNON ELECTRIC

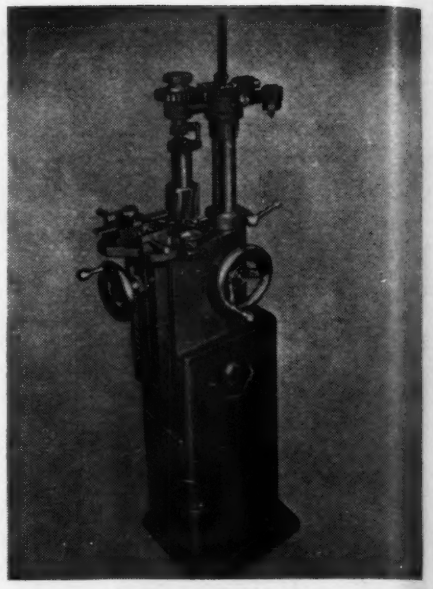
Cannon Electric Development Company
Los Angeles 31, California

Canadian Factory and Engineering Office:
Cannon Electric Company, Limited • Toronto, Canada

bench miller. Spindle head arm support, 2½ in. dia., is clamped rigidly to a column on which it can be rotated 60 deg. either side of center. For horizontal milling, enclosed spindle head is removed. With a 6x14 in. table having three ⅝ in. T-slots on 2 in. centers, machine stands 30 in. in high on its base. Table movements are made by splined hand cranks and read on dials graduated in thousandths of an inch. Motor of ⅓ hp. on floating mount provides for proper belt tension, and spindle speeds can be changed from 450, 850, 1,400, and 2,000 rpm. up to 2,100 without use of tools. Spindle has a No. 2 Morse taper.—AVIATION, *Sept.*, '43.

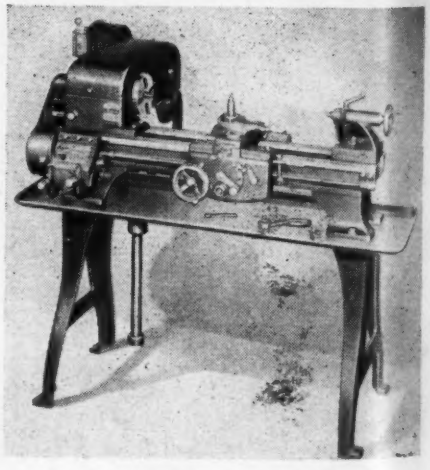
Cutter Checker 51

For checking hook or rake angles and flute spacing when sharpening thread milling cutters, **Detroit Tap & Tool Co.**, has designed this machine which provides visual aligning of a ground straight edge with face of cutter flute. Against an illuminated background, worker can read offset distance directly from an integral micrometer barrel. Errors in flute spacing can be read on an integral indicator dial connected to a finger resting against cutting face. Machine's three chief components are a base mounted on a pedestal, an adjustable dual mount with dual cutter head for hook and space checking, and hook and flute space measuring assembly. Capacity range includes cutters from ½ to 6½ in. o.d. up to 12 in. long, and inspection of all cutting faces can be made up to 7 in. of flute length. —AVIATION, *Sept.*, '43.



Gear Lathe 52

For work requiring frequent changes in operating speeds, No. 820 gear lathe has been introduced by **Logan Engineering Co.**, Chicago. With 48 threads and feeds in either direction, two levers provide for adjustment of screw threads from 8 to 224 per in. Substituting 24-tooth stud gear for one with 48 teeth increases available threads from



Acme for Action
ARMY
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NAVY
Action, trigger-quick action, sets the enemy on the run as our boys land on foreign shores. And quick action on the home front in producing needed equipment will help keep the enemy on the run.
So here at Acme we constantly strive to break production records in supplying patterns, dies, heat-treated aluminum castings, and specialized tools needed by war plants to speed production of war materials.
Acme service is complete, including engineering counsel when desired. Submit your requirements without obligation.
ACME PATTERN & TOOL COMPANY Inc., DAYTON, O.
Heat-Treated Aluminum Castings—Patterns—Tools—Tool Designing—Production Processing
For VICTORY buy WAR BONDS and STAMPS

"HOLD EVERYTHING"
Have you post-war production or operating plans involving use of hydraulic lines?
Then investigate . . . Aeroquip Self-Sealing Couplings "hold everything"—permit instant disconnection of liquid-carrying lines without loss of fluid, or inclusion of air on reconnection. High and low temperatures; pressures to 2000 lbs.
War-tested around the world on American aircraft.
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TESTOR CHEMICAL CO. TESTORS ROCKFORD, ILL., U.S.A.

CONTROL LABORATORY DATA SHEET

CAMOUFLAGE LACQUER, CELLULOSE NITRATE
PRODUCT

14105B Army Air Force SPECIFICATION NO.	219 BATCH NO.
APPEARANCE: Homogeneous, smooth dries to lusterless finish. Color: Olive Drab #41.	**ADHESION:** Excellent adhesion to zinc chromate primed surfaces, aluminum and steel.
TOXICITY: Non toxic	**RESISTANCE TO FLUIDS:** Immersion in water and aliphatic hydrocarbon does not affect the lacquer film.
NON-VOLATILE: 46%	**FLEXIBILITY:** Withstands 180° bend around 1/8" diameter rod after 96 hours bake at 212°F.
VISCOSITY: 1.35 poise at 25°C. when 2 volumes lacquer are thinned with 1 volume Thinner (AN-TT-T-256).	**INFRA-RED REFLECTANCE:** Has infra-red reflectance lower than Aircraft Gray and higher than Olive Drab Porcelain Standards.
WORKING PROPERTIES: Good leveling. Wet hiding power (Thinned Lacquer) 1200 Sq. Ft. per Gal. (Pfund Cryptometer).	
DRYING TIME: To touch - 2 1/2 minutes; hard in 10 minutes.	
LIFTING PROPERTIES: Non-lifting at any time.	

REMARKS: 14105B Camouflage Lacquer is a fast drying final coating for high speed production schedules. Its excellent durability, resistance to water and hydrocarbons, good adhesion and quick dry time perform the work of an ideal aircraft finish.

TESTORS

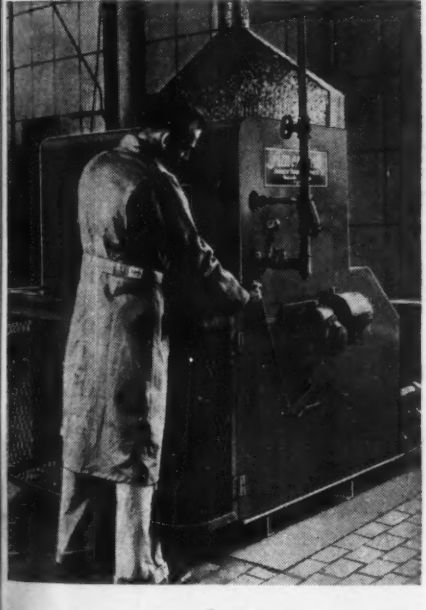
AIRCRAFT FINISHES

TESTOR CHEMICAL CO., ROCKFORD, ILLINOIS, U.S.A.

4 to 7 per in. Longitudinal power feeds range from .0015 to .1000 in. per revolution on the spindle; power cross feeds are .25 times longitudinal feeds. In longitudinal and cross feeds an automatic apron operates from a spline in the lead screw through a worm drive and friction clutch. Bed length is 43⅜ in. and possible swing over it is 10½ in.; distance between centers is 24 in.—AVIATION, *Sept.*, '43.

Washing Machine..... 53

Flat work or cylindrical parts with complex indentations can be washed, rinsed, and dried without removal from this machine. They are placed on a mesh table and rotated under an alkali solution or solvent emulsion sprayed from specially machined nozzles. When cleansing spray is stopped, parts continue to rotate and drain for a few minutes, and, by a special arrangement of drainplates, may be rinsed with water. Compressed air may then be used for final drying. Strainers remove chips and foreign matter from cleaning solution as it recirculates, and spray system can be removed for cleaning and adjustment. Standard machine, offered by **American Foundry Equipment Co.**,



Mishawaka, Ind., will accommodate parts of 25 in. dia. and 12 in. height, and models are also available with tables of 30 and 42 in. dia.—AVIATION, *Sept.*, '43.

Cylinder Borer..... 54

For boring deep cylinders in landing gear struts and in recoil cylinders, machine can work on two pieces independently and simultaneously on its two sections mounted on three ways. Separate headstocks drive each of the pieces which are supported on adjustable, three-point, roller, steady rests. Specifications given by manufacturer, **W. F. and John Barnes Co.**, Rockford, Ill., are: Stroke 12 ft.; swing 25 in. dia.; length of part 67 in. max.; maximum boring diameter 14 in.; bar size guide bushing 12 in. max., pilot 6 in. max.; spindle centers 26 in.; spindle height from ways 20 in.; spindle hole 6¼ in. dia.; spindle nose flange 11 in. dia.; spindle speeds 18 to 295 rpm. standard, 4 to 60 rpm. optional; feed rate ⅛ and 7½ in. per min. max.; transverse rate 90 in. per min. forward, 80 in. per min. return; spindle motors 15 hp., 1,200 rpm.; hydraulics motors 5 hp., 1,200 rpm.; coolant pump motors 10 hp., 1,200 rpm.; weight is approximately 68,000 lb. when machine is mounted on skids and ready to be shipped skidded. —AVIATION, *Sept.*, '43.

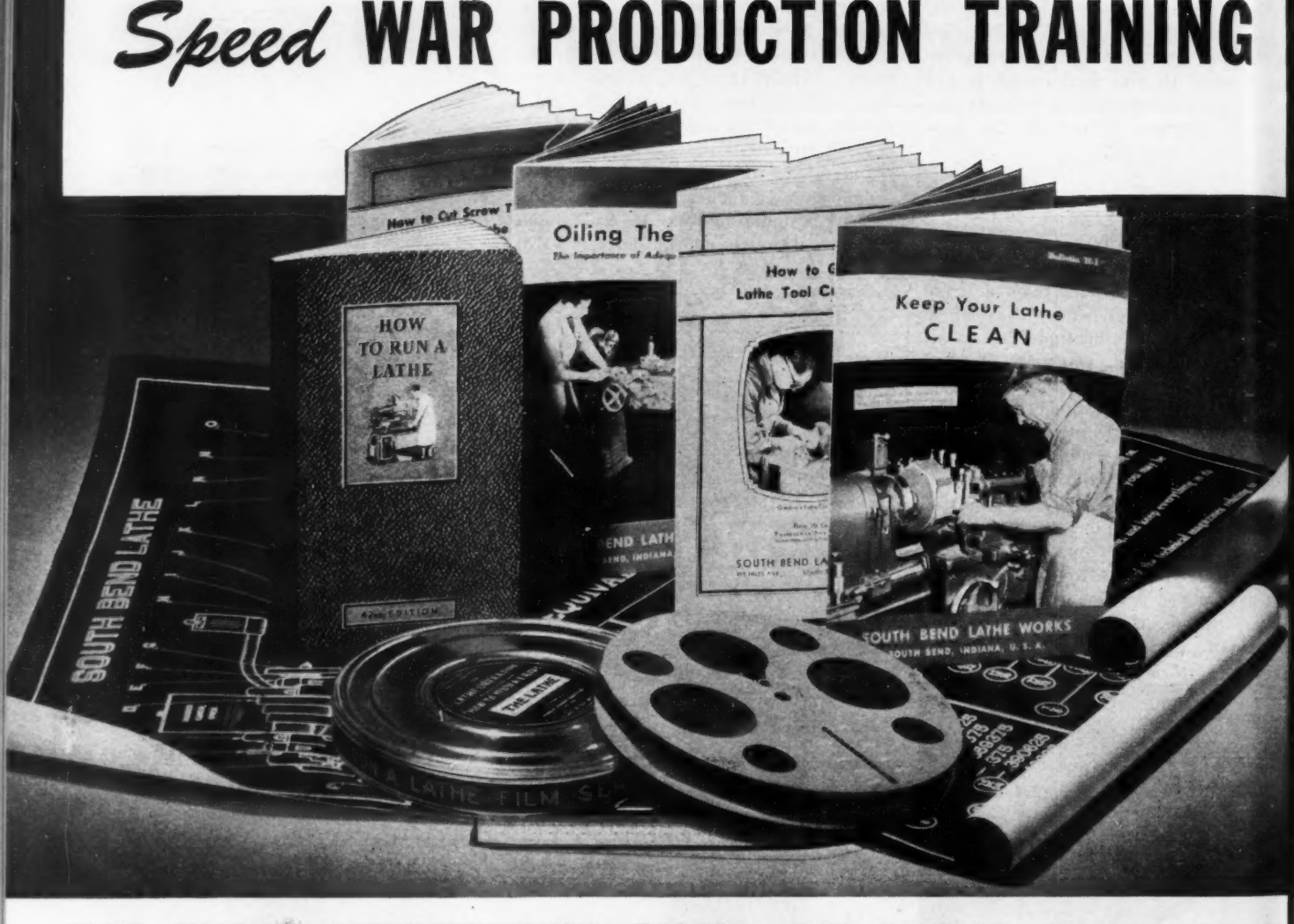
This mechanical
BLIND RIVET
helps all three
THE ENGINEER, by using Cherry Rivets, can disregard blind spots in riveted structures. He designs up to efficiency, rather than down to a manufacturing limitation.
THE PRODUCTION MAN can increase output by using Cherry Rivets ... gets a better job in blind or hard-to-get-at places. One man does the job. No bucking bar is needed.
THE SERVICE MAN does a better job in less time. Does not have to ream holes because Cherry Rivets work well with reasonable tolerance in grip length and hole size.
Make the hard jobs easy with
Cherry Blind Rivets

CHERRY RIVETS, THEIR MANUFACTURE AND APPLICATION ARE COVERED BY U. S. PATENTS ISSUED AND PENDING.

Cherry Rivet Company
LOS ANGELES, CALIFORNIA

Get the complete story on Cherry Blind Rivets in the Handbook A-43. Request yours from Department A-110, Cherry Rivet Company, Los Angeles 13, California.

Speed WAR PRODUCTION TRAINING



USE THESE BOOKS AND FILMS ON LATHE OPERATION

One of the most serious problems confronting management today is the training of new employees to replace thousands of skilled technicians who have been called for service with the armed forces. With inexperienced workers, production goals must be increased and standards of precision and quality must be maintained. To accomplish this, a vast army of men and women must acquire new skills in the shortest possible time.

To help you train new lathe operators, we offer the practical aids listed below. These books and films on lathe operation have proved effective in hundreds of apprentice training schools, including Army and Navy training stations.

Write for Information on These Practical Training Helps

MOTION PICTURES—"The Lathe" and "Plain Turning"—two 16 mm sound films in color on lathe operation. Available on a free loan basis for apprentice training. Showing time 20 minutes each. Write for circular.

HOW TO GET THE MOST OUT OF YOUR LATHE—Specialized service bulletins on the care and operation of engine lathes. H-1, "Keep Your Lathe Clean"; H-2, "Oiling the Lathe"; H-3, "Installing and Leveling the Lathe"; H-4, "Keep Your Lathe in Trim." Sample copies mailed on request.

HOW TO RUN A LATHE—A practical 128-page operator's handbook. 360 illustrations. Written in simple, non-technical style easy for the beginner to understand. Used as a shop text book by the Army, Navy and Air Corps. Price 25c. Sample copy free to apprentice supervisors.

THREAD CUTTING—21-page book, "How to Cut Screw Threads in the Lathe." Shows how to set up a lathe for cutting various pitches of screw threads; setting cutter bits; screw thread formulae; metric threads, etc. Price 10c. Sample copy free to apprentice supervisors.

GRINDING CUTTER BITS—12-page book on grinding lathe tool cutter bits. Covers identification and application of various bits, methods of grinding, correct angles, etc. Price 10c. Sample copy free to apprentice supervisors.

ARMY E NAVY

SOUTH BEND LATHE WORKS

LATHE BUILDERS FOR 36 YEARS — SOUTH BEND, INDIANA

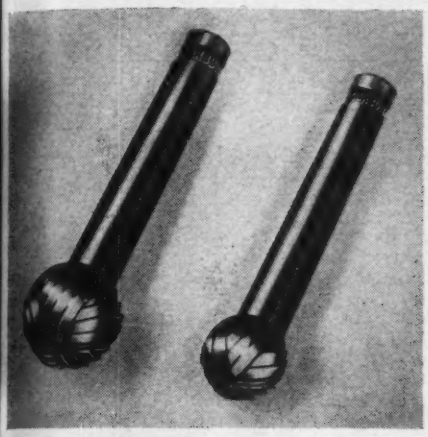
SOUTH BEND ENGINE LATHES

Shop Equipment and Accessories

NEW PRODUCTS

Carbide Burrs..... 55

Said to have greater life, new line of cemented carbide burring tools has been introduced by **Carbur, Inc.**, Lincoln Park, Mich. Teeth are ground from solid



parts and attached to steel shanks by a special fastening process. Manufacturer, reporting savings in machining time, announces that present burrs are supplied in $\frac{3}{8}$ and $\frac{1}{2}$ in. ball and end types on shanks .250 in. dia.; over-all length is $2\frac{1}{2}$ in.—AVIATION, *Sept.*, '43.

Aluminum Coupling..... 56

Fabrication of AN conduit, coupling, and lock nuts from sheet aluminum which is said to make them stronger, lighter, and less expensive is announced by **Rumsen Co.**, Los Angeles. Now in production are sizes -3, -4, -6, -8, -10, -12, and -16 in AN series 3054.—AVIATION, *Sept.*, '43.

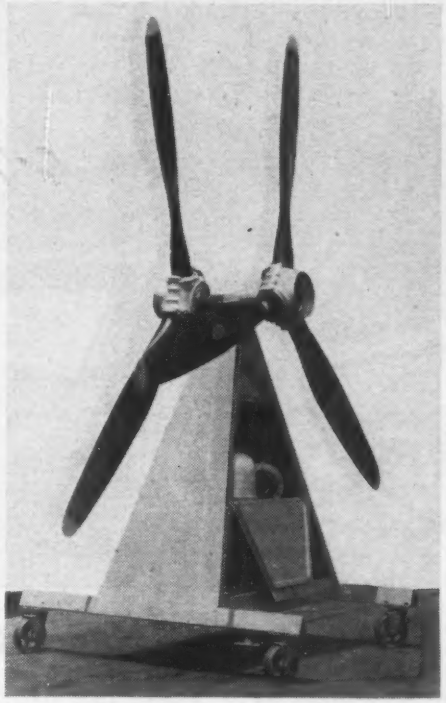
Inspection Cover..... 57

For plywood and fabric-covered aircraft, particularly transport gliders, new inspection hole assembly consists of a Tenite plastic ring and a cover which screws into it. When installing cover in fabric, says **Eastman Kodak Co.**, New

York City, ring is doped and applied with a pre-doped retaining patch. When this fastening is dry, fabric is cut away inside ring. For plywood installations, ring is applied similarly concentric to a previously-cut hole.—AVIATION, *Sept.*, '43.

Propeller Stand..... 58

A new stand for parking two propellers and attachments removed during servicing operations is announced by **Pacific Engineering Corp.**, Los Angeles. Manufactured in three sizes,



stands will accommodate three-blade propellers up to 19 ft. dia. and four-blade up to 17 ft. Material is light gage steel, and base dimensions are approximately 65 x 70 in.; height is 82 in. and weight approximately 295 lb. Brakes are provided on four casters. Two upper storage shelves can be locked.—AVIATION, *Sept.*, 43.

Angle Vise..... 59

Berco Mfg. Co., Chicago, announces a new vise for settings at all angles. Drive wheel motion gives lateral clearance of $2\frac{3}{4}$ in., and double swivel construction allows for any horizontal posi-

ANOTHER GILBARCO CONTRIBUTION

Built especially for aviation fueling service, the Gilbarco Filter-Funnel has been approved and used for ten years by the U. S. Navy, as well as by commercial air lines, private fliers, and the air forces of our Allies.

The Gilbarco Filter-Funnel is designed to promote added safety in flight by eliminating such causes of motor failure as sand, lint and water in gasoline. It represents one more Gilbarco contribution to the technique of fueling and servicing modern aircraft.

Gilbarco

ARMY E NAVY

GILBERT & BARKER MFG. CO.
WEST SPRINGFIELD, MASS.

PRODUCTION'S "GENERAL STAFF"

War winning strategy can be represented by new ideas engineered by American industry. Techniques and "gadgets" often solve more than individual plant problems. They aid war production as a whole! For example, Solar has developed several innovations which save time, material and labor.

These are available to other manufacturers to help keep America's airpower a formidable weapon for victory. Typical product of Solar "staff work", is a new welding flux that has a higher melting point and prevents oxidation of thin gauge stainless steel and other high alloy metals.

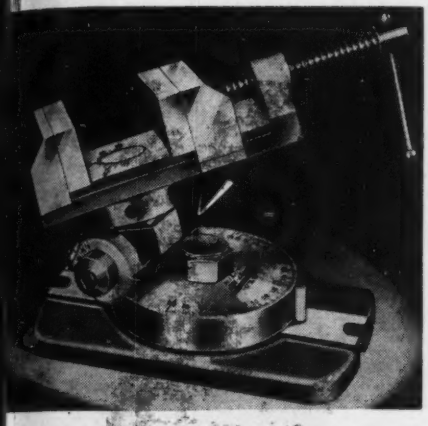
ARMY E NAVY

SOLAR

EXHAUST SYSTEMS

SOLAR AIRCRAFT COMPANY ★ SAN DIEGO 12, CALIFORNIA

tion. Other features are right angle clearance for unobstructed perpendicular positions and positive horizontal

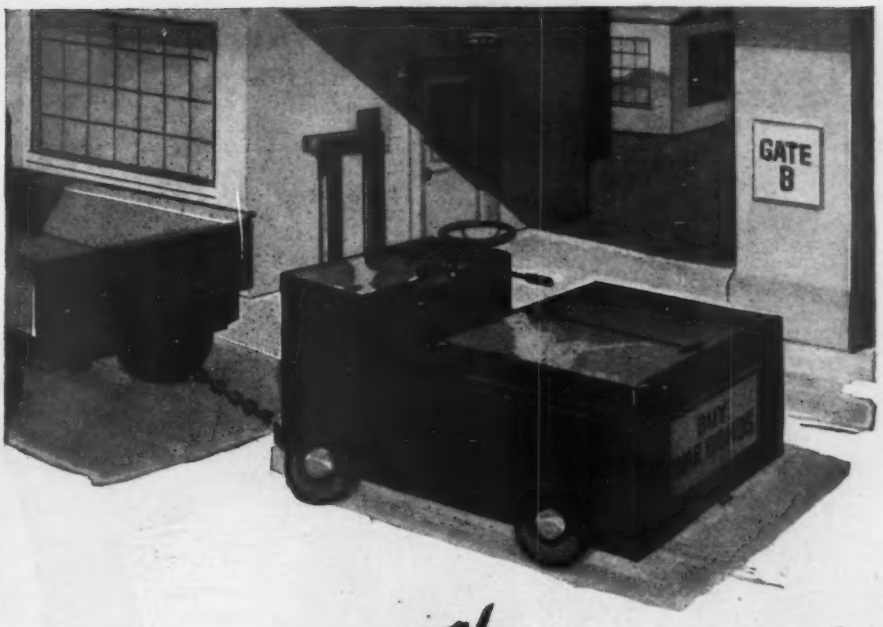


measurements. Models are built with jaw widths of 3½, 4½, and 6 in.—AVIATION, *Sept.*, '43.

Transmitter 60

A new type 50-w. ultra high frequency transmitter is announced by **Air Associates, Inc.**, Los Angeles, to meet Civil Aeronautics Administration present and future radio communication requirements. A similar unit, convertible to ultra high operation, is also being produced for low frequencies. The high frequency unit, designated Model TUI, features fire cabinet construction with four racks mounted on ball bearing tracks. Frequency range is 126-132 mc. and that of low frequency unit, Model TMO, is 200-400 kc. Two crystals are provided with each transmitter, one active and other for replacement; hinged doors on three top racks are provided as a protection to tuning adjustments, and cooling blowers are an integral part

• Announcements of new machine tools and shop equipment and accessories are invited for inclusion in these columns. In writing, emphasis upon aviation industry applications of newly-marketed items is desirable, and, wherever possible, glossy-print photos should be enclosed for illustration. Manufacturers should address New Products Editor, AVIATION, 330 W. 42nd St., New York City.



Caught with Its Battery Down!

Long hauls or a hard day's work will often leave the battery of an electric truck run down. That's understandable. Inexcusable and unnecessary is the waste of precious manpower, material and time in "shipping" them back to a central charging station. They can be recharged *on the spot* by G-E battery-charging rectifiers placed at strategic locations so they're always on the job. Further, they are fully automatic, require no special training to operate. Just plug in and the charger does *everything else.*

Detailed data sent on request. Write to Section A934-84, Appliance and Merchandise Department, General Electric Company, Bridgeport, Connecticut.

GENERAL ELECTRIC

THE RELAY for that TIGHT SPOT

Size isn't the most important feature of a relay, of course, but the Clare Type K d.c. Relay combines all of Clare's "custom built" ruggedness and dependability in a size and weight to fit into designs where inches and ounces count.

Shown here in exact size, the Clare Type K measures but 1½" x 1¼" x 13/16". It can be furnished in the contact forms shown with as many as 12 contact springs.

The Clare Type K Relay is designed for applications incident to vibration . . . no special anti-vibration springs are needed. There are no bearings to chatter and wear as uniform armature movement is maintained by the use of a "fatigueless" beryllium copper hinge, heat treated and designed to provide a wide margin of safety.

Permanent assembly tightness is secured by binding the spring pileups under hydraulic pressure and then tightening to the heel piece. A coating of Glyptol is an added precaution.

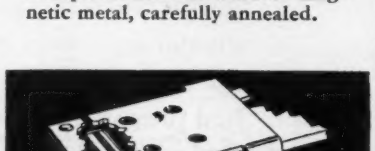
All metal parts of the Type K are specially plated to withstand a 200 hour salt spray test. Heat treated Bakelite insulators provide the minimum moisture absorption required by rigorous Army and Navy tests.

Like all Clare relays, this Type K is "custom built" to do just the job you have for it. Let us place the experience of our engineers at your service. Write us your specifications today.

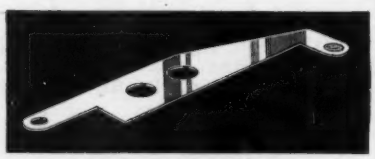
Send for the Clare catalog and data book. C. P. Clare & Company, 4719 W. Sunnyside Ave., Chicago, (30) Ill. Sales engineers in all principal cities. Cable address: Clarelay.

Strong, hard, long wearing Bakelite bushing insulators resist vibration and heavy contact pressures.

Heelpiece and coil core of magnetic metal, carefully annealed.



Hinge of "fatigueless" beryllium copper insures long life under vibration.



Nickel contact springs to which contacts are overall welded by special process.

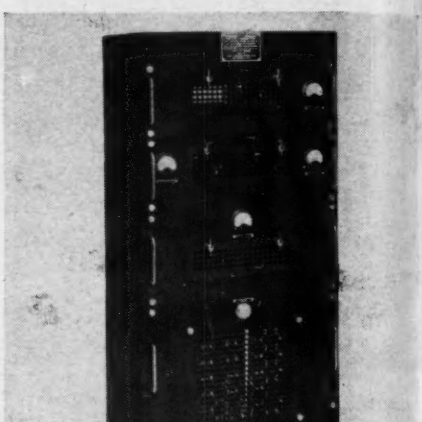
CLARE RELAYS

"CUSTOM-BUILT" Multiple Contact Relays for Electrical, Electronic and Industrial Use

NEW PRODUCTS

of each rack, drawing filtered air through glass wool in bottom and discharging it through opening in top.

External appearance of two transmitters is identical. Two lower racks of



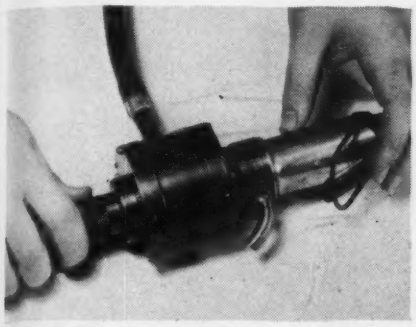
each are interchangeable and contain power supply and modulator units. Two top racks of low and ultra high frequency models are same size. By removing them from low frequency model and replacing them with racks of high frequency unit, TMO is converted to ultra high frequency. This provision was made to meet ultimate plan of CAA to handle all airport traffic communication on ultra high frequencies. In interval of converting from low to ultra high frequency, certain airports will be equipped with four transmitters, two low and two high, one pair of each for duty and one for stand-by service.—AVIATION, *Sept.*, '43

Countersink 61

An adjustable stop-countersink is announced by **Aircraft Tools**, of Los Angeles. Known as Model C, it is being manufactured in two cutter sizes, 7/16 and ⅝ in. The shell housing is bell shaped, gives a greater bearing surface, and keeps cutter square with hole. A ratchet stop, permitting easy depth adjustment by hand, snaps into position at each two-thousandth of an inch. Positive lock-ring maintains same depth regardless of jarring or rough use. Drive shaft runs in oilite bearings with ball thrust bearing to take up shocks and insure accuracy and long life. Cutters are fabricated from high speed tool steel.—AVIATION, *Sept.*, '43.

Rivet Shaver..... 62

An air-driven portable tool for removing aluminum alloy protuberances, such as rivet heads, from airplane surfaces is announced by **Shego Co.**, Washington, D. C. Named the Rivet Shaver,



tool is a precision milling machine intended primarily for rapid removal of excess rivet material remaining above smooth skin surface after driving operation. Accurate control of degree of smoothness of shaving operation is provided by adjustable guide wheels (under side) upon which shaver is rolled by operator in a series of short, swift, advancing motions. A range of adjustment of approximately .050 in. is provided to allow for reduction in cutter radius due to re-sharpening. Model 31, illustrated, weighs 5 lb., measures 13x4x3½ in., and will shave protuberances up to ⅜ in. wide. Another model is available for ¾ in. widths.—AVIATION, *Sept.*, '43.

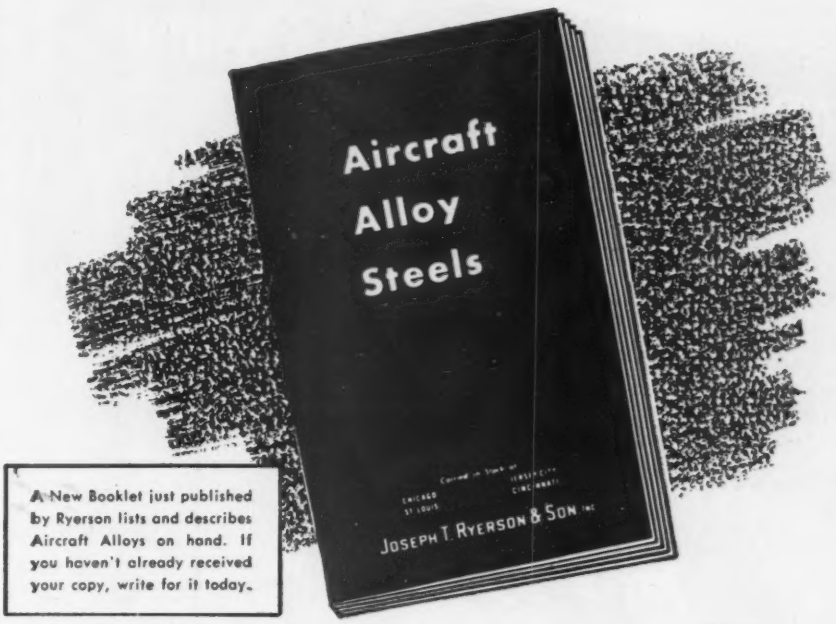
Plastic Heating 63

Girdler Corp., Thermex Div., Louisville, announces new high frequency equipment for heating plastics, woods, and other non-metallic materials preparatory to molding. Current passed between flat electrode plates on either side of material causes molecular resist-

ance which produces heat. Coils, tubes, and controls are contained in a cabinet which is available with casters.—AVIATION, *Sept.*, '43.

Turret Reverser..... 64

Developed at request of a plane manufacturer by **Adel Precision Products Corp.**, Burbank, Calif., hydraulic valve automatically controls swing of gun turrets so that they do not come in contact with plane. When turret swings into predetermined danger arc, an electric circuit is closed; this activates a solenoid which in turn tips a cam in the valve, reversing hydraulic flow and consequently motion of turret. When turret has swung 2 in. in reverse direction, valve cuts out and turret operates as usual. Reversing process can be accomplished in 1/20 sec. Valve, including enclosing aluminum alloy body, weighs 3.24 lb. and measures 2¼x2¼x6 7/16 in. Operating on 24 v., d.c., solenoid draws about 15 apm.—AVIATION, Sept., '43.



A New Booklet just published by Ryerson lists and describes Aircraft Alloys on hand. If you haven't already received your copy, write for it today.

Ryerson Aircraft Alloys

8630-X4130-4140

In Stock for Immediate Shipment

Ryerson stocks at Chicago, St. Louis, Cincinnati and Jersey City include the above alloy steel bars in a wide range of sizes. These are earmarked stocks conforming to specifications: AN-S-14, AN-QQ-S-684 and AN-S-752 respectively. They are available under the Gov. ACW plan.

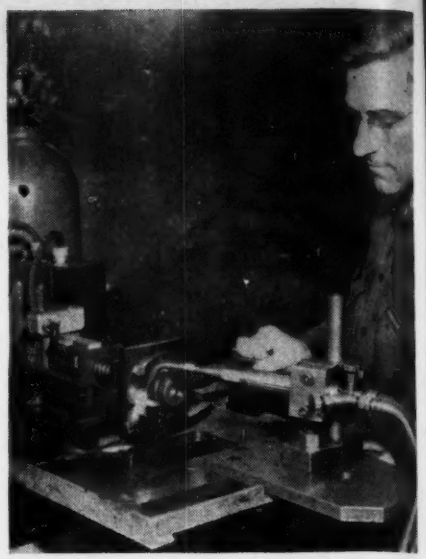
The helpful Ryerson special Aircraft Alloy Steel booklet includes: listings of available stocks; condensed versions of all the AMS and the ANS specifications which pertain to steel.

Besides our aircraft alloys, at ten plants we carry over 10,000 different kinds, shapes and sizes of steels on hand to meet any need which might arise. A call to Ryerson first . . . will assure quick delivery of the right steel. Joseph T. Ryerson & Son, Inc. Plants at: Chicago, Milwaukee, St. Louis, Detroit, Cleveland, Cincinnati, Buffalo, Boston, Philadelphia, Jersey City.

RYERSON STEEL-SERVICE

Flame Hardeners 65

Bench and floor model flame hardeners for small parts have been designed by **Hydraulic Machinery**, Detroit, incorporating multiple-duty holders, various burner tips and an automatic timing cycle which retracts a solenoid thus dropping the part into a quenching medium under heating fixtures. Standing on a welded steel base, floor model, made especially for hardening sprockets, is fully automatic. When sprockets are in place on indexing table, table moves into position among torches and quenching heads. Pilots ignite torches and water begins to flow through quenching heads. As table moves forward, it trips an electric timer, which regulates length of time heat is applied to roots of teeth. When interval is up, indexing table



turns sprocket to a new position and repeats operation until all teeth have been hardened.—AVIATION, *Sept.*, '43.

Air Lubricator..... 66

An automatic lubricator which feeds oil in a regulated amount into air stream passing through air-driven equipment, eliminating daily oiling is announced by **Filters, Inc.**, Glendale, Calif. It is installed from 1 to 6 ft. from tool in rubber hose. Light in weight, device is provided in two standard settings which prevent flooding. A positive wicking action with an automatic shut-off controls oil flow. Reservoir holds enough oil for more than a week under normal usage and a clear Lucite window shows when it needs re-filling. Using a differ-

ent fitting, lubricator can also be installed in air pipes of larger stationary or semi-portable tools. It is also adaptable for air passages in machinery.—AVIATION, *Sept.*, '43.

Plywood Nut..... 67

Approved by AAF for use in plywood construction, self-locking fastener consists of a nut and basket. Four prongs on basket sink into plywood, and two feet, inserted into hole, are forced into

ADJUSTABLE Holding Stands *for Speeding Up* PRODUCTION WELDING and ASSEMBLY . . .

At right: Model 1504, Plain Stand for handling light parts.

At left: Model 1503, Geared Stand, for handling heavy parts. Gear ratio, 72 to 1.

STALEY welding stands are quickly adjustable for length, permitting any kind or length of welding or assembly jig to be mounted, revolved to any desired position, and locked. Stands are furnished without holding fixtures, but the revolving brackets are drilled and tapped for mounting. Fixtures can be mounted off-center so that fixture and work balance, making it easy to turn over when loaded. Equipped with casters and quick-acting floor stops. Capacity, 3,000 lbs. Write for literature on the complete line of STALEY Engine Stands.

Staley MANUFACTURING CORPORATION

COLUMBUS, INDIANA, U. S. A.

wood as nut descends, anchoring basket. Spring fingers on basket clasp nut when it is seated, and four prongs on washer

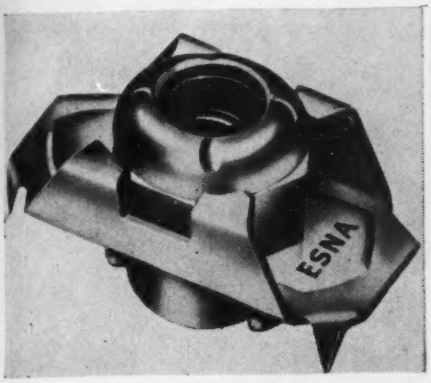


plate keep it from turning. Nut can be installed in plywood from ⅛ in. up with a hammer, forced in with a press, or drawn by a bolt. **Elastic Stop Nut Corp.**, Union, N. J., reports it can be replaced without moving basket.—AVIATION, *Sept.*, '43.

Plastic Dials..... 68

Plastic is substituted for brass name plate and aluminum base in dial assemblies being manufactured by **Aircraft Specialties Co.**, Los Angeles, and approved by U. S. Air Forces. Lighter, less expensive, and effective saving in strategic materials are advantages claimed for this new product.—AVIATION, *Sept.*, '43.

Moisture Sealing..... 69

New method of sealing aircraft parts to prevent rust and corrosion during shipment involves placing sacks (lower left in photo) containing granular silica gel, a substance which can absorb half

WHEN AIR BATTLES HINGE ON *Fast* REFUELING...

Fighting planes require fast refueling and service. Every minute counts. Pumping units, powered by small gasoline engines, provide faster servicing of planes. Here again, some of the hundreds of thousands of dependable, instant-starting Briggs & Stratton engines, now serving our armed forces, are on combat duty.

Meeting wartime demands for Briggs & Stratton gasoline engines has proved a BIG JOB. But we like big jobs. In fact, we'd like to see just how big a job we can handle with our facilities for high quality, precision production.

We will welcome the opportunity of discussing your 4-cycle, air-cooled gasoline engine requirements — either for immediate or post-war needs.

BRIGGS & STRATTON CORP.
MILWAUKEE 1, WISCONSIN, U. S. A.

FOR VICTORY BUY WAR BONDS

4 CYCLE
BRIGGS & STRATTON
GASOLINE ENGINES

TAKE AWAY AIRPOWER!

TAKE away airpower, and the job of winning the war becomes terrifying in its immensity. Our strategy of fluidity, surprise, and preparatory softening would stagnate to one of position with military advances measured in feet instead of hundreds of miles. Everywhere on the globe, footholds in enemy territory would be gained only at calamitous loss of life.

Is it any wonder that America's eyes are turned skyward? Isn't it natural for us to depend on aviation to bring an earlier end to the war, and to assure the continuance of peace by making neighborliness the keynote of worldwide diplomacy? Airpower, a faint shadow over the world in 1918 has become the very substance of our hope today. It is the part of Fleetwings to vitalize that hope with its contribution of planes and plane parts.

Fleetwings-made wings, fins, stabilizers, ailerons, flaps, and hydraulic valves for America's fastest and best aircraft flow from the production lines in a floodtide . . . every part a promise of a better future—each piece an omen of our nation's permanent airmindedness. Fleetwings, like all industry, is in it for victory, but Fleetwings is in it too—for a sound and continuing peace.

FLEETWINGS

FLEETWINGS

pioneers with parts and hydraulic equipment

The BT-12, all-welded basic trainer built for the U. S. Army Air Forces.

WELDING SCHOOL GOES MODERN Because the old apprentice method of teaching welding was too slow for wartime production speed-up, Fleetwings' welding school has streamlined its course and is turning out first class welders in double-quick time. The whole subject of welding is taught thoroughly. Instructors insist that each worker understand the theory and principles of welding before doing any practical work. And, as a part of the training, students follow a regular welder through his routine work—learning first hand how welds should be made.

NEW IDEAS DEPARTMENT When the rivet sorting problem became acute at Fleetwings, the Special Tool Development Department came to the rescue with a sorting device guaranteed to save man hours aplenty. It's nothing but a turning barrel screen on the order of those used in collieries for grading coal. With it, one operator can match the turnout of twelve workers using the old hand sorting system.

HYDRAULIC VALVE DIVISION Fleetwings pioneered in the aviation valve industry for its own ships and is still pioneering in production methods and shortcuts. As war work multiplies, Fleetwings' hydraulic valve division follows through with greater precision and finer craftsmanship. Watch for the announcement of a new group of slide selector valves.

THE ARROW, Fleetwings' monthly magazine, will help you to keep informed. In its pages are described the new production methods, shortcuts, and news of interest to men and women in the aircraft industry. If you'd like to receive a copy each month, write us on your company stationery. Send your request to "THE ARROW," Fleetwings, Inc., Bristol, Pa., Plant No. One.

FLEETWINGS

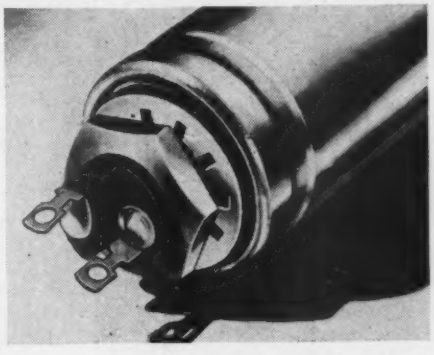
Division of Kaiser Cargo, Inc.

BRISTOL • PENNSYLVANIA

its weight in water, at strategic spots about an engine, for example, which is then sealed in a moisture-proof bag. Framed in a transparent window in the bag is a moisture indicator card of cobalt-impregnated silica gel. Card changes color with changes in moisture content in bag. Made by **Permutit Co.**, New York City.—AVIATION, *Sept.*, '43.

Oil Capacitor..... 70

Double terminals are now available on its type 10 oil capacitor according to **Aerovox Corp.**, New Bedford, Mass., thus eliminating insulating washer for-



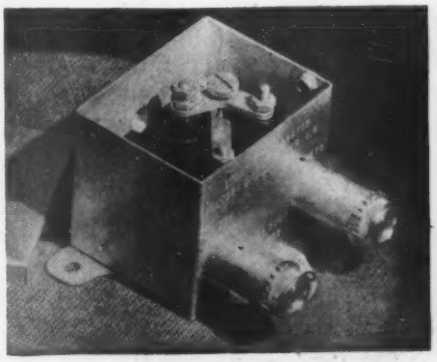
merly required with grounded-can models. Bakelite terminal assembly is moisture proof, protecting apparatus' hermetical sealing and contents, either vegetable or mineral oil. Capacitor is rated at up to 4 mfd. at 600 v., d.c. and to .5 mfd. at 1,500 v., d.c. Cans are made of aluminum or approved substitutes.—AVIATION, *Sept.*, '43.

Generator Brushes 71

Stackpole Carbon Co., St. Marys, Pa., announces manufacture of generator brushes for use in planes flying above 30,000 ft., where they are said to give longer service. Brushes are produced according to a process developed by Westinghouse.—AVIATION, *Sept.*, '43.

Starting Vibrator 72

To provide ignition for aircraft engines, new starting vibrator announced by **General Electric Co.**, Schenectady, N. Y., delivers pulsating current of 1.8 amp. at 24 v., d.c. directly to magneto low voltage winding. Transformer ac-



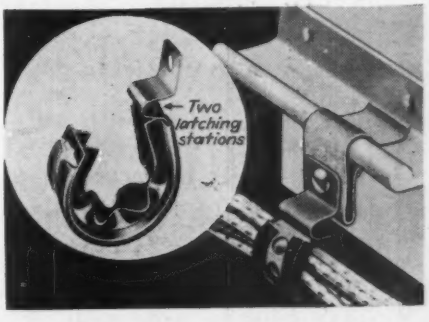
tion within magneto steps this input up to high ignition voltage. When starting cycle is completed, vibrator automatically cuts out.—AVIATION, *Sept.*, '43.

Oil Re-Conditioner 73

Unit for reconditioning cutting, grinding, and honing oils by heating has been put on market by **Sparkler Mfg. Co.**, Mundelein, Ill. To prevent loss of sulphur, lard, wax, etc., oil is heated in machine from 170 to 200 deg. F. before filtering. Apparatus, 25x72x58 in. and weighing 1,400 lb., consists of 100-gal. mixing and heating tank with immersed electrical heaters which will raise oil temperature from 80 to 180 deg. in 30 min. There are also mechanical agitators, thermometer, filter aid storage box, 600-gph. filter, rotary pressure pump, and 1 hp. motor. Machine is mounted on casters. Manufacturer says it will sterilize and restore oils to their original efficiency.—AVIATION, *Sept.*, '43.

Wire Harness 74

Electrical wiring harness clamp has two latching stations (left in photo) through which end of holding backet can be adjusted to accommodate bundles of

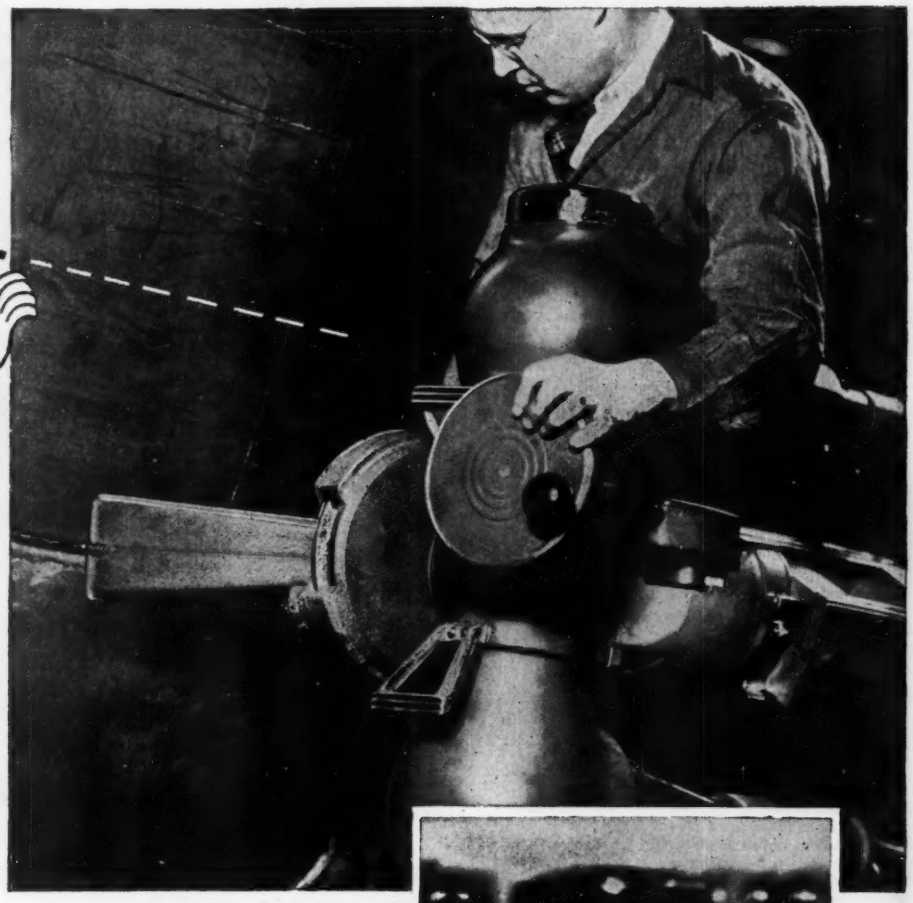


different size without affecting mounting screw. Holding bracket is made of Parkerized spring steel finished with two coats of lacquer and cushioned with extruded synthetic rubber channels. Six sizes to accommodate bundles from 1/16 to 1⅜ in. dia. are available from **Tinnerman Products**, Cleveland.—AVIATION, *Sept.*, '43.

Fly Cutter 75

Latest addition to line of **Robert H. Clark Co.**, Los Angeles, adjustable two-blade fly cutter with straight or taper shank can cut holes from 4 to 10 in. dia.

"Casing the joint" WITH X-RAY



X-RAY INSPECTION DETECTS HIDDEN DEFECTS IN WELDS... ASSEMBLIES ...SLABS OF STEEL!

Today, subsurface flaws literally live in glass houses. For x-ray lets inspectors look right inside welds, complicated assemblies, or a heavy slab of steel to detect flaws and to guide their repair as well.

Where vital parts must meet wartime standards of perfection —or else, x-ray inspection steps up the *real* productivity of the plant. Parts with hidden flaws are spotted and rejected before a lick of machining is done—or assembly begun. Lost time is minimized.

Inspection by x-ray is *fast*. Radiographing up to an average of 700 parts an hour and better, is a matter of record. That speaks volumes for ease of operation ... greatly simplified by Westinghouse-developed controls on all units.

Inspection of welds is only one of hundreds of production jobs now being done faster, better and cheaper with Westinghouse X-ray. Others include quality control and product improvement; conservation of materials, machines and man power; employe training.

J-08064

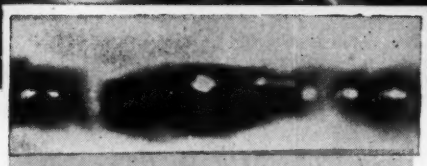


EXHIBIT "A"... This radiograph shows porosity and improper fusion in a welded joint. Only x-ray can visualize such internal defects.

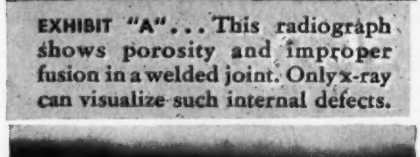


EXHIBIT "B"... This radiograph shows a perfect weld as indicated by the continuous dark uniform strip in the center.

FOR MORE FACTS, write for our new X-ray Inspection Book—B-3159. Tells how and where to use x-ray and how to select the right x-ray equipment. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., Dept. 7-N.

LOOK INSIDE WITH X-RAY

Westinghouse X-RAY

PLANTS IN 25 CITIES... OFFICES EVERYWHERE

in metals, plasties, and live rubber up to 1 in. thick. Company is also producing three-blade model for cutting diameters from $\frac{5}{8}$ to 5 in. and for making holes in pipe and curved surfaces as well as four types of surfacing tools with expansion capacities of 1 to 5 in. Bits on all of them can be reground and replaced.—AVIATION, *Sept.*, '43.

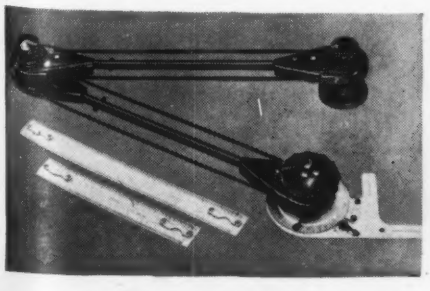
Plastic Blower 76

Delivering 15 cfm. at 3,000 rpm. tiny blower of one-piece, high-impact molded plastic has cadmium plated steel turbo

wheel of $1\frac{1}{2}$ in. dia. and total weight of but 2 oz. Back plate has been designed by **L-R Mfg. Co.**, Torrington, Conn., to facilitate mounting on any type motor. —AVIATION, *Sept.*, '43.

Portable Drafter 77

For mounting on portable board, new small drafting machine features parallel motion over entire board, full circle base line setting, pre-lubricated sealed ball bearings, and enclosed pulleys. Employing many plastic parts, machine weighs 3 lb. and is furnished with disk brake at anchor and elbow for use on steeply inclined boards and with plastic



PARTS INVENTORY SLASHED 91% with Increased Output!

With LAMSON CONVEYORS

In a humming aircraft engine plant, a Lamson engineer set out with company officials to speed production. Lamson Conveyors in the crank case department reduced the distance parts travel from over a mile to 1600 feet. With the efficiency achieved by expert coordination, the parts inventory was cut to 1/12 its former size. The savings on interest alone paid for the entire installation in ONE WEEK!

Incredible? Yes—almost. Yet this is but one of the many such reports of amazing economies in time and money and corresponding increases in production achieved by Lamson . . Lamson Conveyors eliminate the confusion and waste of outmoded materials moving methods and multiply the output of available manpower.

No matter what you make now—or expect to make after the war—it will pay you to have a Lamson materials-handling engineer make a survey of your plant and suggest ways to modernize and streamline production.

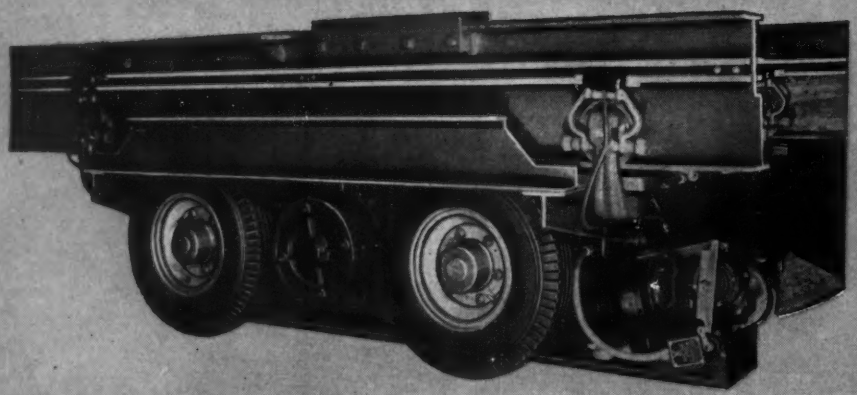
Smashing bottle-necks is an old story to Lamson engineers

LAMSON Corporation

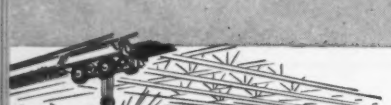
Dept. AV SYRACUSE, N. Y.

Makers of CONVEYORS and PNEUMATIC DISPATCH TUBES

Greater *PULL* than any other traction method . . .



with GENERAL JUMBO Jrs. on this special installation by American MonoRail Co.



Partial view of installation showing General Jumbo Jrs. on MonoRail *carrier* . . . further proof of Jumbo Jr. versatility!

A massive steel tank-turret is lifted, *red-hot,* by magic hands . . . wafted through the air to a quenching bath on an ingenious hoist and overhead conveyor system specially designed by The American MonoRail Company, Cleveland, Ohio.

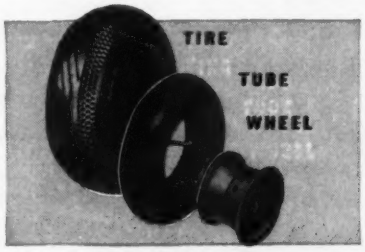
And Jumbo Jr. industrial pneumatics are on this job! American MonoRail engineers have found that a fractional horsepower electric motor operating a pneumatic tire against the bottom of a MonoRail track, can pull combined loads exceeding 10,000 lbs.

The use of General Jumbo Jrs. on this special job is further proof that the Jumbo Jr. *tire-tube-wheel* combination is the team to pick . . . whether "in the air" or "on the ground." Jumbo Jrs. roll easily . . . protect load, truck, floor or dock. Traction is exceptional . . . the pneumatic principle resists picking up of filings, chips and clippings. Exclusive and patented, Jumbo Jrs.' design makes possible service unequalled by any other industrial tire!

★

Available in new air corps specification sizes. Also for war orders and certain essential industrial uses.

★



Tires 8" to 24" overall diameter. Load capacity 100 lbs. to 1500 lbs. per tire. 2-4-6 and 8-ply with separate tubes and heavy duty wheels.

For further information write or call—

THE GENERAL TIRE & RUBBER CO.

AKRON, OHIO

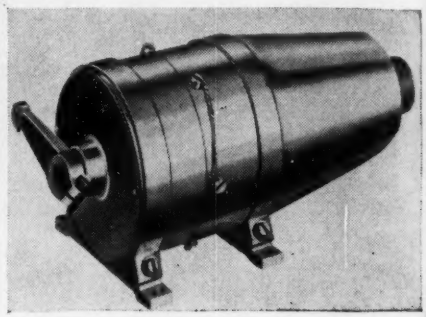
GENERAL JUMBO JR.

INDUSTRIAL PNEUMATIC TIRES

central skid button which does not mar paper. Aluminum scales, 8 and 12 in. long, are available to fit into slotted chucks in positive scale holder, and protractor, 3¾ in. dia., is graduated in degrees with figures by quadrants. A 10 min. vernier plate is available from maker, **V & E Mfg. Co.**, Pasadena, Calif. —AVIATION, *Sept.*, '43.

Control Motor 78

Designed for control work in aircraft dampers and controlling temperatures, intercooling apparatus, and valves on various liquid lines, motor is housed



in aluminum case with enclosed switches set for 90 and 180 deg. rotation. Control itself may be positive, floating, or proportioning with a manual or automatic step for remote position indication. Torque, according to maker, **Barber-Colman Co.**, Rockford, Ill., is 50 to 500 lb./in. and weight approximately 3 lb.—AVIATION, *Sept.*, '43.

Bonding Cement 79

Tests have been announced on a new cement for bonding natural or synthetic rubber and plastics to iron, steels, magnesium, aluminum, copper, bronze, and brass. Strength of the assembly at room temperature, 212, and 300 deg. F. for rubber of 50 Shore hardness was reported as 1,885, 595, and 360 lb., respectively. Known as the Reanite bonding process, the new cement is sprayed or laid over surfaces which have been brushed. After cement has set for an hour, surfaces are joined and vulcanized. Photo shows ¼-in. tire tread cut away from aluminum to which it had been cemented. Manufacturer, **U. S. Stoneware Co.**, Akron, says joints are

unaffected by water and have good corrosion-resistance and high dielectric strength.—AVIATION, *Sept.*, '43.

Insulating Tubing 80

Industrial Synthetics Corp., Irvington, N. J., announces two new materials for electrical insulation and other tubing purposes. The products are (1) "Synflex FT-11," a transparent flexible material with a temperature range of −60 to +186 deg. F. and dielectric strength of 1,000 vpm.; (2) "Synflex FT-22," a rubber-like synthetic insulation and tubing with dielectric strength of 1,200 vpm. Neither material, it is said, will support combustion and both have good chemical resistance and low water absorption. They will stretch to tight fits over lugs and splices and can also be blown over flexible or rigid conduit. Available sizes are .021 to 2 in. i.d.—AVIATION, *Sept.*, '43.

Milling Cutters 81

Standard styles of carbide tipped milling cutters being made by **Machinery Mfg. Co.**, Los Angeles, include end, staggered tooth, shell end, face, and half side mills. Two types, bore face and adjustable end and step mills, can be regulated for various radii; two models of latter have four or six tips which can be adjusted by micrometer screws.—AVIATION, *Sept.*, '43.

Paint Recovery 82

Originally formulated to prevent emulsifying oils, resins, and dispersing pigments from breaking water curtain in paint spray booths, Turco Deflocculator, reports **Turco Products**, Los Angeles, has also been found useful as a chemical recovery agent in preventing formation of scum on tops of tanks and thus producing a higher quality sludge. Company recommends that ½ oz. of compound be dissolved in 1 gal. of water and addition of ⅛ oz. per gal. every 4 hr.—AVIATION, *Sept.*, '43.

Tachometer Tester 83

Link-Belt Co., Philadelphia, announces variable speed drive for vertical or horizontal testing of up to four tachometers in the same or opposite directions simultaneously. Integrally mounted ½-hp. motor drives two pairs of opposed coni-

Your plane will have a 'phone!

After the war...

...the two-way radiotelephone will be employed by American industry as a convenience, a safeguard and a business requirement. This modern method of communication has many proven applications in the following fields:

Aviation	Railroading
Marine	Mining
Police Patrol	Fire Fighting
Trucking	Engineering

Public Utilities

If you think you may be able to employ two-way radiotelephone communication in your field, we would be pleased to discuss your problem without cost or obligation. We have nothing to sell since our entire output has been placed at the disposal of the United Nations all over the world!

•

Requests for information and literature from responsible parties may be addressed to Jefferson-Travis Radio Manufacturing Corporation, 380 Second Avenue, New York.

SOUNDS fantastic, doesn't it? Yet the incredible wartime development of the two-way radiotelephone in military aviation is striking evidence that it will be widely used by the planes, cars and trains of tomorrow. Jefferson-Travis was in the forefront in the development of this unique form of communication long before Pearl Harbor. Today our entire facilities are devoted to producing this type of equipment for the United Nations, thus hastening the day when we will be again building two-way radiotelephones for you and your peacetime purposes in Tomorrow's World!

JEFFERSON-TRAVIS

RADIOTELEPHONE EQUIPMENT

NEW YORK • WASHINGTON • BOSTON

...with **X-RAY**

—the modern way to check internal clearances

It's easy to make sure that mesh and clearances between gears and housing of completed mechanical assemblies are "right"... look inside with Westinghouse X-ray. Inspection of completed tab gear boxes for fighter planes is one of many unusual jobs where Westinghouse X-ray saves time in the plant... lives and equipment on the front. J-02016

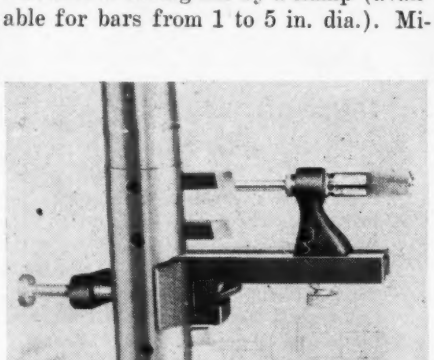
More dope? See Page 256

Westinghouse
X-RAY
PLANTS IN 25 CITIES... OFFICES EVERYWHERE

cal disks. Speed delivered to shafts can be controlled by hand wheel which requires 5.84 turns to cover tester's 10 to 1 range capable of delivering shaft speeds of 200 to 2,000, 250 to 2,500, and 300 to 3,000 rpm. Vernier controls for more exact regulation are available with ratios of 7.7 or 30 to 1. Link-Belt also announces new features in its line of variable speed rigs for testing aircraft vibrators, pumps, and instruments. One model has a 2 hp. vertically mounted motor controllable over a 6 to 1 range and delivering 600 to 3,600, 300 to 1,800, and 150 to 900 rpm. to three test shafts with a fourth extension available over range of 150 to 900 rpm. for tachometers. Shaft speeds can be regulated by handwheels.—AVIATION, *Sept.*, '43.

Boring Micrometer 84

Bartelt Engineering Co., Beloit, Wis., is producing a "pedestal micrometer" for setting close spaced boring tools and gaging height and depth. Device is fastened to boring bar by a clamp (available for bars from 1 to 5 in. dia.). Micrometer arm can be set on either top or bottom of carrying arm, which is designed so that boring tools 3½ in. apart can be set without changing the pedestal. Only one trial cut is said to be necessary to obtain measurement for setting tools with micrometer. Dial indicator reading in tenths or thousandths may be substituted for micrometer.—AVIATION, *Sept.*, '43.



Molding Plastics 85

Eight phenolic moldings designed to conserve supply of phenol have been announced by **Bakelite Corp.**, New York City, along with a new high impact-resistance molding material, BM-16468. Latter is a black phenolic plastic with a string filler. Tests on molded specimens indicate these physical properties: Compressive strength (parallel direction) 27,500–32,700 psi., (transverse direction) 15,600–18,200 psi.; tensile strength (transverse) 7,500–8,500 psi.; flexural strength (parallel) 12,000–12,900 psi., (transverse) 10,200–14,200 psi.; maximum deflection (parallel) .086–.122 in., (tranverse) .095–.118 in.; impact strength Izod (parallel) 3.49–4.84.—AVIATION, *Sept.*, '43.

Hose Fitting 86

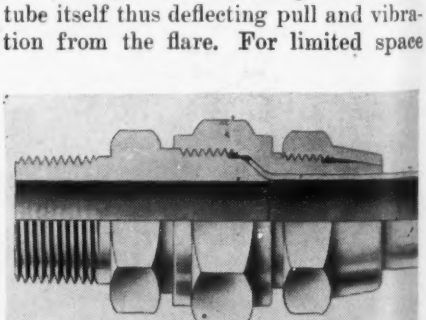
Developed to meet growing need for Dural bulkhead hose fittings for pressurized cabins, a new series of joints, known as AN848-20, is announced by **Hartwell Aviation Supply Co.**, Los Angeles. New fitting is made in one unit and three diameters ranging from ¼ to 1½ in. It provides a relief space, one and a half threads wide, between shoulder and first thread to permit lock nut to be tightened against a thin bulkhead partition. Except those made from barstock, fittings are tested by air under kerosene to 100 lb. gage pressure. Company is also manufacturing host fittings of AN840 to 847 series and is tooled to produce them from manganese bronze as well as dural.—AVIATION, *Sept.*, '43.

Assembly Stand 87

Model E-5 assembly stand designed by Aviation Div. of **Whiting Corp.**, Harvey, Ill., employs extension bar, interchangeable rotating bed plates, and accessories making it suitable for radial cylinders and engines and in-line or V-blocks or engines.—AVIATION, *Sept.*, '43.

Tube Fitting 88

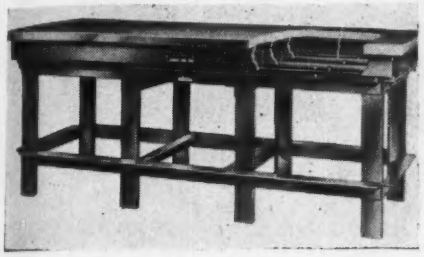
Nut in new hydraulic tube fitting compresses collet nut to tubing and compensates for variations in outside diameter. Digging and cutting of tube is said to be avoided and resulting joint is unaffected by vibration. In double nut series (illustrated for tube from ¼ to 2 in.) design is intended to place load on tube itself thus deflecting pull and vibration from the flare. For limited space installations, single nut series is being produced for tube from ¼ to 1 in. by



Cotner-Wilkinson Co., Logansport, Ind. —AVIATION, *Sept.*, '43.

Layout, Surface Plates..... 89

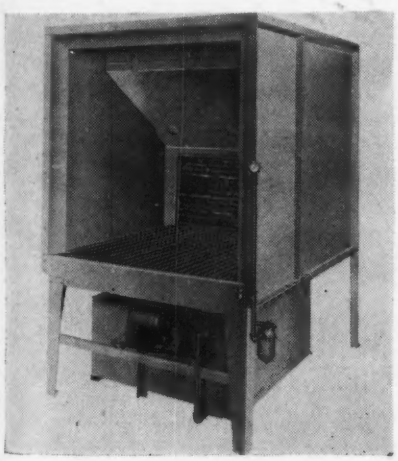
Two accessories for inspecting, adjusting, and measuring are being made by **Challenge Machinery Co.**, Grand Haven, Mich. One, a long layout surface plate, has V-blocks, one mounted permanently, the other sliding along T-slots to permit adjustment in any position along table top. Other product is a layout plate (illustrated) with overhanging



edges for holding work clamps. Leveling screws allow work to be trued and locked in position. Four sizes are available, 36x72, 40x96, 48x96, and 48x128 in.—AVIATION, *Sept.*, '43.

Degreasing Booth 90

Features of new spray-degreasing booth announced by **DeVilbiss Co.**, Toledo, include minimum loss of organic solvents, more thorough removal of fumes, and more powerful solvent spray.

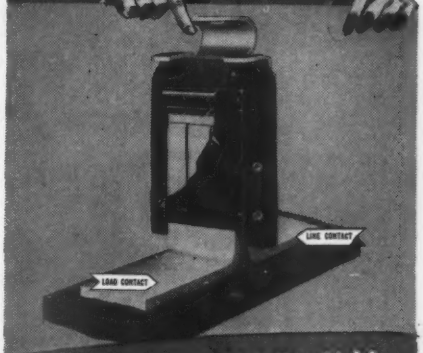


Built in sizes to meet requirements of various materials handled, booth is available in 14, 16, and 16 gage steel—AVIATION, *Sept.*, '43

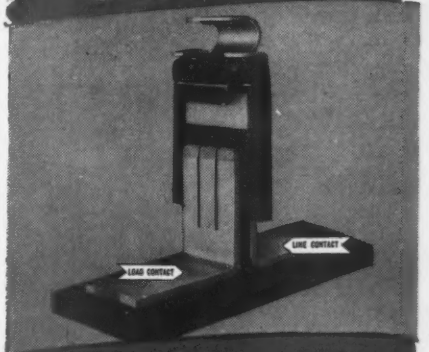
Plated Plastics 91

Process of plating rigid and pliable plastics and other non-conductors with various plating metals has been perfected by **Precision Paper Tube Co.**, Chicago, which reports that method is effective on convex or concave surfaces, convolutions, and other configurations.—AVIATION, *Sept.*, '43.

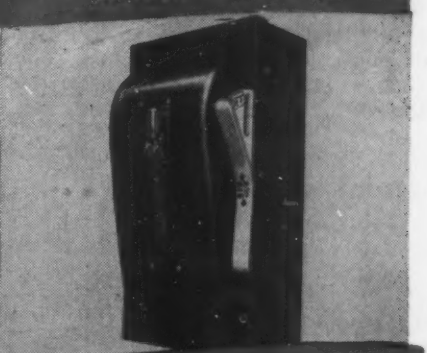
WHY Vacu-Break SAFETY SWITCHES?



PARTIAL VACUUM quickly smothers arcs

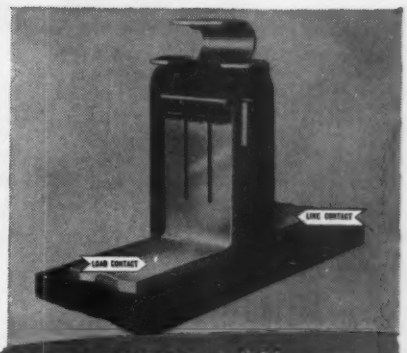


CONTACTS MAKE AND BREAK with automatic ease



PUSH-TYPE, FRONT-OPERATED rocker handles enhance the fine effect of streamlined switch cabinets.

Here's Why—



CONTACTS (IN ON POSITION) tight as a bolted connection

BullDog's Clampmatic Vacu-Break design combines in a simple construction the two features most essential to flawless safety switch performance — *clamp-tight contacts* and *easy operation.*

It is worth remembering that BullDog — with all its advantages of simplicity, fine appearance and positive action — costs no more than switches *without* this thoroughly modern design.

Ask your BullDog field engineer to give you his interesting mechanical demonstration of the Clampmatic Vacu-Break principle.

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ELECTRIC PRODUCTS CO.
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BullDog Electric Products of Canada, Ltd., Toronto, Ontario
Field Engineering Offices in All Principal Cities

MANUFACTURERS OF a complete line of Vacu-Break Safety Switches, Panelboards, Switchboards, Circuit Master Circuit Breakers and BUStribution SYSTEMS.

• • •

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With the kind of tool that reaches the *"hard to reach"* rivet. Give 'em the gun with a YORK ELECTRIC...

ROUND THE CORNER RIVETER

Adapter

Fits any standard Pneumatic Riveter

★ ★ ★

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that save labor and material

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Developed by the America's leading aircraft tool design engineers and have successfully met Army and Navy tests.

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A new portable Tape Printer that produces any new code mark or series of letters and digits instantly. It permits each aircraft plant to print its own without costly delays.

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An automatic dimpler adapter that speeds production and avoids spoilage.

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Wire printed by this has been immersed in gasoline and oil for one-hundred hours without damage. It has withstood the Army and Navy's severest tests.

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The Bolton Ignition Harness, now on leading warplane engines, is the result of intensive research. The high quality, tested materials embodied in this product provide the reserve toughness and flexibility needed to safeguard an engine's complex ignition. The design itself assures supreme quiet from spark interference.

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NORTH AMERICAN gets more arcs per generator

...and better welding with the WILSON "HONEY BEE"

This battery of Wilson "Honey Bee" stations helps North American Aviation, Los Angeles, Calif., to get *better quality welding* on light metal – and *more welding* from every constant potential welding machine.

Two Wilson "Honey Bees" are connected to every Wilson "Hornet" generator, thus doubling the number of welding operations that can be performed at once from a single generator. Each operator using a "Honey Bee" station holds a remote arc control switch, which enables him to regulate his current from zero to maximum while welding – without first extinguishing the arc. In addition, the "Honey Bee's" Remote Crater Control permits the operator to fade out the arc slowly to prevent craters, porosity, and similar weld defects.

The Wilson "Honey Bee" is made in 75 amp. and 150 amp. sizes. For full details write to Wilson Welder and Metals Co., 60 East 42nd St., New York 17, N. Y.

Long favored by operators for its fine all-around performance, the Wilson "Hornet" gives excellent service as a power source for "Honey Bee" stations. A convenient switch may be mounted on the "Hornet" for quick change from standard to constant potential characteristic, and vice versa. This is advantageous where the "Hornet" is used for general purpose welding as well as for use with "Honey Bee" stations.

WILSON

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General Offices: 60 East 42nd Street, New York 17, N. Y.

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FOLLOW THESE GOOD MAINTENANCE PRACTICES

1. Keep every welding machine protected when it's not in use. Don't, however, cover the machine when running — it needs ventilation.

2. Don't overload your machine. For instance, do not use the machine continuously above its rated capacity. This causes overheating and charred insulation.

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4. Check all connections regularly to insure perfect contact. Loose connections may cause erratic operation.

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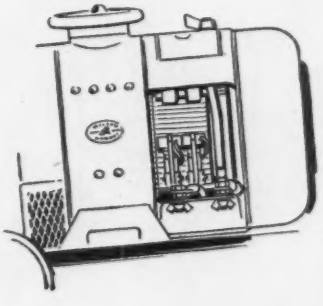

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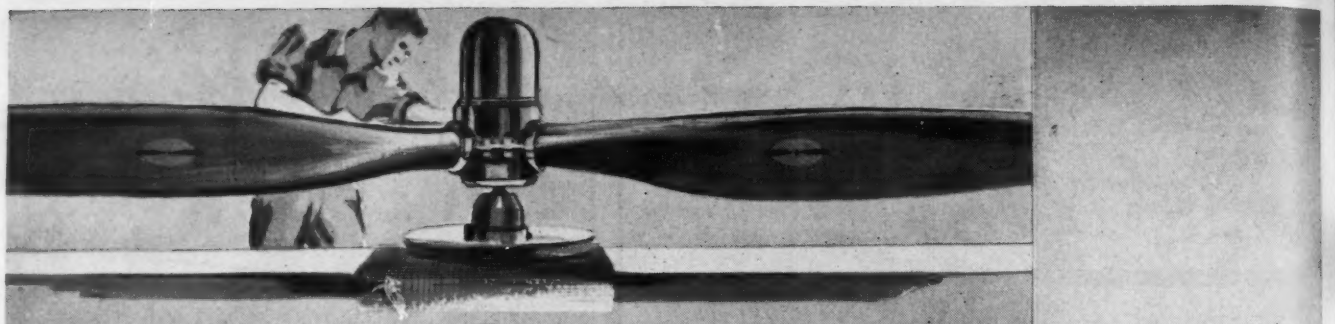

Over Europe.. With ever-increasing tempo the 8th U. S. Army Air Force is carrying its daylight bombing program deeper and deeper into enemy territory. In carrying out these precision missions, Consolidated Liberators, Vega Venturas, and Boeing Flying Fortresses are flown high and far with latest type HYDROMATICS.

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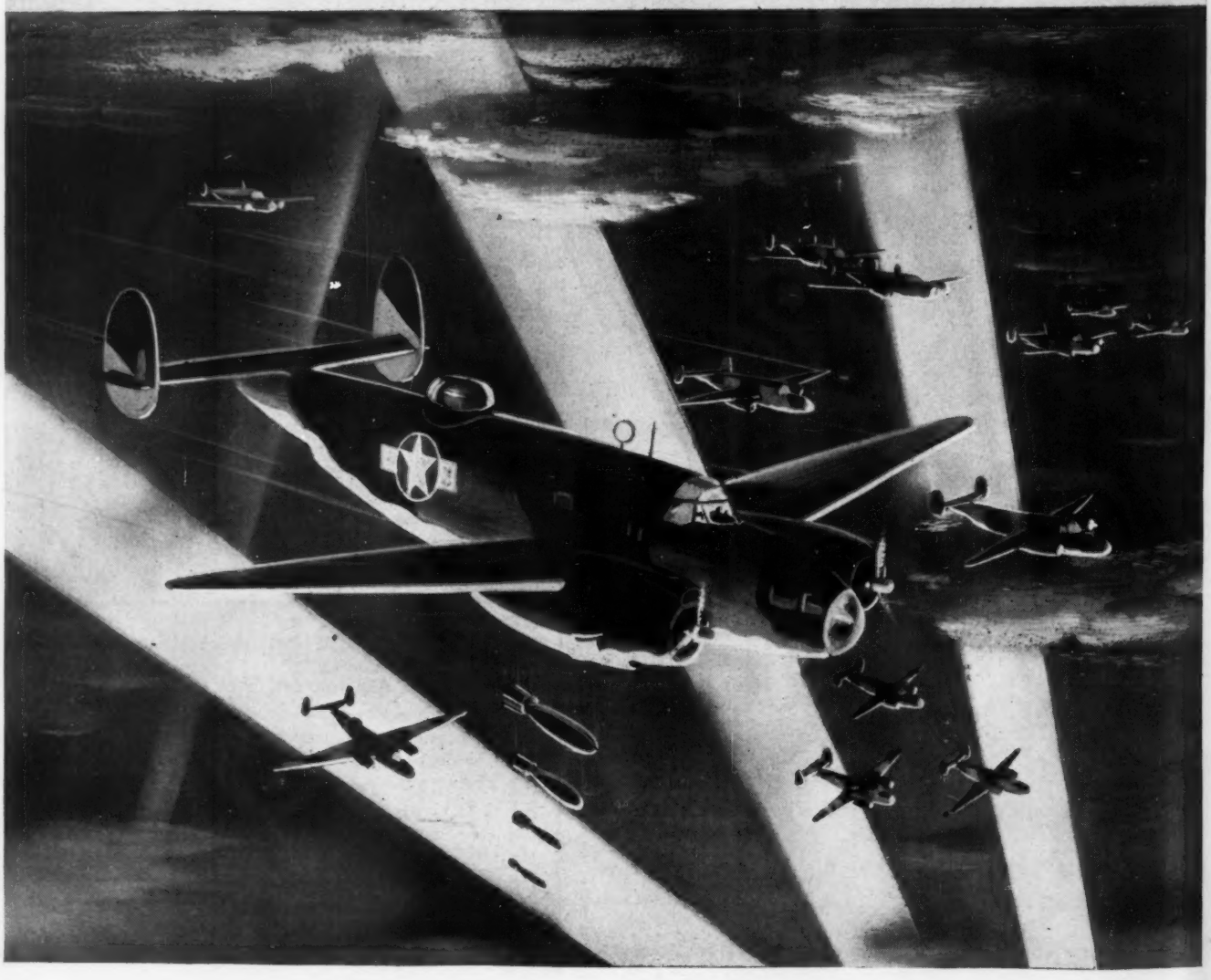


The AVIATION NEWS

BLAINE STUBBLEFIELD, Washington HERB POWELL, New York

No "Blanket" Draft Deferments Planned Although Hirings Fall Behind Resignations

Los Angeles (Special to AVIATION)—Growing seriousness of the manpower shortage in aircraft manufacturing was recognized last month when Selective Service ordered a 60-day deferment for West Coast workers.

That the move was not a final solution to the problem was clearly indicated when Maj. Gen. Lewis B. Hershey, NSS director, declared that no "blanket" deferment will be granted the aircraft or any other war industry. In testimony before a special two-man House Military Affairs subcommittee here he emphasized that the order was merely a postponement—which does not alter the status of draft-vulnerable aircraft workers—in order to give Selective Service time to study the situation.

Reps. John M. Costello (Calif.) and Forest A. Harness (Ind.), the two-man special committee, heard testimony from a long list of aircraft and parts plants executives, all of whom indicated that if new draft replacement schedules are carried out, West Coast and possibly other aircraft production centers will be retarded and new design engineering will positively come to a halt.

Following brief testimony by Gov. Earl Warren, who painted an over-all picture of California's manpower shortage problems, the case for the aircraft plants was sketched by J. H. Kindelberger, president of North American Aviation, who filled in details of what the new orders will do to his company's key personnel.

Summary of the airframe plants case was tersely put by Pres. Robert Gross of Lockheed, who stated: "A government decision is needed, whether airplanes or soldiers are wanted from aircraft plants."

The case for blanket deferment was outlined by Mr. Kindelberger in the following figures: West Coast airframe plants have already lost 66,000 men to the armed forces; today they are short 20,000 workers; to meet current schedules, these plants must increase their forces by an estimated 36,000 employees before December.

In the first six months of this year, Coast plants hired 150,000 workers but lost 138,000, through all causes including the military, for a net gain of only 12,000. Most plants, at mid-year, reported hirings falling behind terminations. Coast aircraft personnel is not only deficient in numbers, but the bulk of the employees also lack qualifications, experience, and training.

The new Selective Service regulations make nearly 58,000 men now employed in the air-

(*Turn to page 270*)

Naval Feelings Mixed On McCain Appointment

Washington (AVIATION Bureau)—The battle for a strategic air command goes on silently here and at the fronts. Occasionally it breaks into the open.

Latest boil-up is over Pres. Roosevelt's appointment of Vice Adm. John McCain to the new office of Deputy Chief of Naval Operations (Air) in the Office of the Chief of Naval Operations. Some air officers had hoped that an air officer would sit in with the chiefs of staff. They do not regard McCain as an air officer, despite the fact he made a good record as commander of aircraft during the battle of the Solomons. Middle-of-the-road Naval airmen, however, regard the appointment as a step in the right direction.

Adm. McCain succeeded Adm. John H. Tower as chief of the Bureau of Aeronautics last September. At that time a new office was created for Tower: Commander Air Force, Pacific Fleet. Navy called it the most important aviation job afloat.

Succeeding Adm. McCain as chief of the Bureau of Aeronautics is Rear Adm. D. C. Ramsey.

July Production Up 297 Units

With materials available for 8,500 planes, the manpower crisis, particularly acute on the West Coast, kept production 627 units below schedule for July. The month's total of 7,373 was up only 297 over June. Heavy bombers increased 13 percent to a new high.

The desired year-end rate of 10,000 units a month will probably not be met. Washington expects no more than 9,200 now and perhaps under 9,000 if the requirements for heavy bombers are not increased.

While military men were obviously alarmed over the failure of the aircraft and other industries to meet schedules, Donald Nelson emphasized that "production is not falling off . . . however, production has not been increasing as fast as it must to meet the tremendous quota needed by the military services." AAF announces present receipts of 4,500 planes a month.

Charles E. Wilson WPB aircraft vice-chairman, is planning introduction of incentive pay in some West Coast plants.

WORKER-RECRUITING CHAMPION

F. D. Weaver, personnel manager of Boeing's Renton Div., awards a lapel button to Mrs. Belle Newman. In company's new recruiting program, she brought in largest number of new employees.

Reorganized Chamber to Ask Representation On Surplus Disposal, Sets Up Promotion Unit

Washington (AVIATION Bureau)—After nine months of inactivity the Aeronautical Chamber of Commerce is being revitalized to voice the industry's policies.

James P. Murray, vice-president of Boeing, has been named president.

Underlying reason for debilitating the Chamber last winter by depriving it of staff and budget was the lack of competition during wartime. Manufacturers no longer felt the need for mutual services and protections. Many executives now feel that the previous action was hasty, for postwar problems are already arising.

One of them—and of major importance—is the disposition of surplus warplanes. Rep. Clarence Lea has introduced a bill (HR 2959) providing for CAB to handle this job, and Chairman Pogue states that the Board favors a special liquidation corporation.

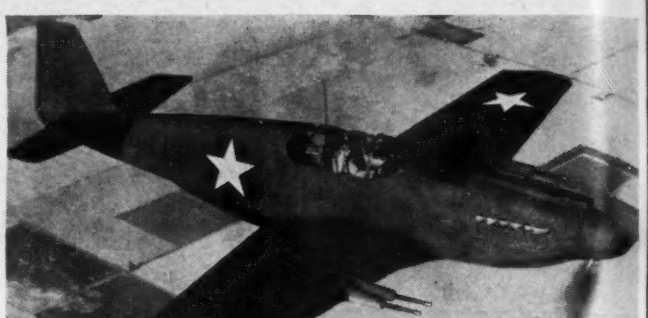
Among its directors would be representatives of CAB and the War, Navy, State, and Treasury departments. Fact that the industry is not included will be immediate business for the Chamber as soon as its revitalization is completed. A demand for representation is expected.

The reorganizing process is complicated by lack of available executive personnel and by the disfavor with which the War, Navy, and other branches of the Administration look upon postwar planning now. Chairman Pogue, on the other hand, says that the industry should be permitted to go ahead with more efficient designs.

While there will be a move in Congress to have all surpluses handled by one instead of separate agencies, Mr. Pogue says that pending legislation for aircraft proposes liquidation which would preserve the economic soundness of the transport and manufacturing industries.

Meanwhile, at a meeting in Chicago, representatives of 20 light plane manufacturers agreed upon the formation of a Personal Airplane Manufacturers' Section within the Aeronautical Chamber. Purpose is to promote personal postwar flying, but this objective will not be allowed to hinder war production.

Details of this unit's organization and budget are being worked out. Chairman of this group is D. Wallace, Cessna president. W. T. Piper, Piper Aircraft, is his vice-chairman; and Richard H. DePew, Fairchild Engine and Airplane, is secretary.



"MUSTANG" HITS EVEN HARDER

Four 20-mm. cannon, particularly effective at ripping open Nazi locomotives, have been installed in wings of some recently produced North American P-51's. In firing tests, cannon ripped foot-long gashes out of target wing sections. Earliest RAF model Mustang had four .50 and four .30 cal. machine guns. Later versions used six .50 cal. weapons.

Canadian Notes

By James Montagnes

Dominion Parliamentary discussion discloses plane production is not yet at a peak for training and service craft. It is pointed out that at the summer's start but 80 planes were being made weekly, that there is a labor shortage in the plants, that orders totalled more than $1,000,000,000, that Canada needs 15 types of engines, that engine-plant tools planned for in '40 were not available, and that accordingly the U. S. has promised to deliver all engines needed. It was also learned that costs per plane are on a competitive basis with those in the U. S. for the same aircraft.

Meanwhile, Munitions and Supply Minister C. D. Howe reported plane production from the beginning of the war to last May 31 as follows: Elementary trainers—DH *Tiger Moth* 1,384; Menasco *Moth* 10; Wireless *Moth* 126; Fairchild *Cornell* 409; and Fleet "16" 431 (a total of 2,360 elementary trainers). Advanced trainers—Canadian *Harvard* 1,059; Noorduyn *Norseman* 51; Fleet "60" 101; Bristol *Bolingbroke* 367; Avro *Anson* 1,850; and *Lysander* 150 (a total of 3,578 one- and two-engine advanced trainers). Service craft—*Shark* 15; Grumman 15; *Stanraer* flying boats 32; *Delta* 8; *Lysander* 75; *Norseman*, 69; *Bolingbroke* 169; *Catalinas* 63; *Hurricane* 1,451; *Hampden* 160; and *Mosquito* 19 (a total of 2,076 service craft). Grand total is 8,014.

Cost of Canadian-built planes, exclusive of engines and plus sales tax, was revealed by Minister Howe as $45,000 for the *Anson;* $4,800 for the elementary *Tiger Moth* trainer; $63,000 for *Bolingbroke;* $28,600 for reconnaissance *Lysander;* $20,000 for Harvard; and $33,750 for *Hurricane*. Unit prices for *Lancasters* and *Mosquitos* were not yet given. In addition, the Minister stated that a new four-engine cargo transport is on the drafting boards for postwar use.

Differences between the plant management and four Canadian members of the seven-man board of directors of the Toronto deHavilland company regarding handling of a potential 150-per-month output of *Mosquitos* recently resulted in the Dominion government placing a controller—J. Grant Glassco—in charge to reorganize the management. Later, the plant is to be returned to the board. Howe reports that deHavilland established an excellent record in previous production of *Moth* and *Anson* planes, and the company's *Mosquitos* are now flying the Atlantic directly into service.

Now being disbanded is Canadian Associated Aircraft, Ltd., formed by six Dominion companies in '38 to make 80 *Hampdens* and other aircraft. The six (Canadian Car & Foundry, Fairchild, Fleet, National Steel Car, Ottawa Car, and Vickers) have been given back their original investment of $166,600 each. Associated had set up two plants where parts for aircraft made by the six were assembled.

Glider Demonstration Satisfies Army Forces

For months AAF chiefs have been studying the probable costs, risks, and military value of combat gliders. The question appears to be controversial. Gen. H. H. Arnold, chief of the AAF, looked into the matter with some doubts as well as enthusiasm.

Last month the AAF Troop Carrier Command, feeling the weight of unfavorable public opinion and wishing to "sell" the Army including Gen. Arnold, put on a two-day demonstration at Laurinburg-Maxton Field in North Carolina. A large group of press and military observers used one word to describe it: Wonderful. Gen. Arnold agreed.

The Army does not appear to accept criticism of its CG-4A glider. Officers admit it lacks aerodynamic refinement, that it is noisy inside, and is far from handsome. But it is a good load carrier, flies easily, has a long gliding ratio, is tough in crashes, and is in satisfactory production. The St. Louis accident is not taken as indicating any design fault.

So the Army is going ahead with plans to land strong glider contingents behind the enemy wherever possible. Satisfaction with the CG-4A does not preclude development of other types, and several projects are in blueprint stages and some in the air.

• On his 72nd birthday Orville Wright paused in his daily routine in his Dayton laboratory and announced that he is working on "an invention having to do with aviation."

★ SPOT CHECKING ★

Grover Loening has been appointed chairman of NACA subcommittee on helicopters.

Postwar volume will be even less than 10 percent of 1944's expected $30 billion—the peacetime estimate of some people—according to J. Carlton Ward, Jr., president of AWPC East. He reveals that a study made for Washington predicts sales of $1 billion.

Any servicing of airplanes for war procurement agencies "whether in their preparation for shipment or subsequent servicing is exempt from price control," OPA announces.

Revealing that six different processes to increase aluminum production, including use of high-silica bauxite, have been approved, WPB announces that "many scientists report that the alumina situation looks better today than it did a year ago." Magnesium production in 1942, it is said, was 30 times that of 1939.

Nearly 1,000 people, Cesena re-

orts, have posted serial numbers of war bonds with the company for priority ratings on delivery of private planes after the war.

Lecithin, compound found to improve lubricating oils by inhibiting oxidation, can now be obtained from soya bean oil.

Poll of investment dealers, made by Hugh W. Long & Co., shows 32 percent believe airlines have best postwar prospects among various business and 44 percent think aircraft manufacturing has worst.

Statement on Foreign Policy Waits As Congress Participates in Decisions

Washington (AVIATION Bureau)—U. S. Foreign air policy cannot be settled till sometime this autumn at the earliest. The Administration was seemingly about to conclude a deal with the British when Congress, hearing objections to closed-door proceedings, especially by Assistant Secretary of State Berle, took a hand itself.

A subcommittee of the Senate Commerce Committee has begun a study of the whole problem. Sen. Clark of Missouri called on Secretary Hull and upon Pres. Roosevelt. Clark offered cooperation: the Administration could accept—or square off for a rousing fight with Capitol Hill. It was agreed that the Executive branch would wait for an expression of opinion from Congress.

The United States and England dominate the entire world air picture. Congress wants to make sure that the Administration does not commit us to a program that would harm our future relations and business with nations other than Britain.

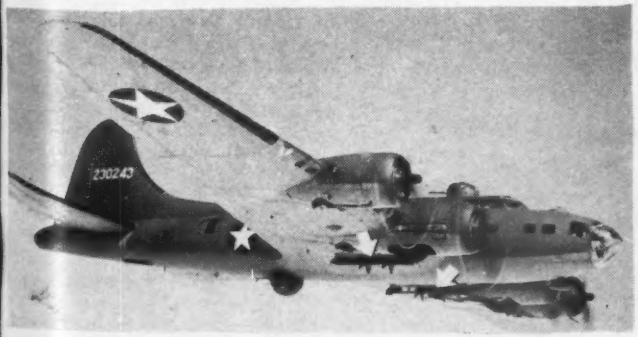
Sen. Clark reported that six possibilities were being considered, among them a government monopoly in foreign flying, organization of a private corporation in which the government might own controlling or minority amount of stock, or the choice of one private line to develop all overseas operations.

Meanwhile, the British government itself is beginning to review its single-foreign-airline policy and to consider the merits of a multiple-company system. Also the matter of auxiliary services by steamship companies is under consideration there, just as it is here. Our Maritime Commission is preparing a report which undoubtedly will recommend to Congress that our merchant ship operators be permitted to institute their own air services.

This air-and-ship plan, which probably will be written by Grover Loening who prepared similar proposals in 1937, is approved by Republican Sen. Lodge. Both the Commission and Lodge are watching air-shipping combinations in other countries for profitable lessons. Lodge and four other Senators, two of them members of the Truman Committee, are checking on American air bases, which will play a leading part in our postwar air program. And the Truman Committee itself may construe this air policy confusion as a war problem and write another report.

In Canada, a policy battle is also impending. Trans-Canada Air Lines has just extended its service to England and thus, as Prime Minister Mackenzie King promised, becomes the sole instrument of Canada's foreign air service. But Canadian Pacific steamship and railroad companies, with their airline subsidiaries in the West, will fight the Prime Minister to extend their air services to the north and south.

Pan American Airways is exerting its full power in favor of a single U. S. foreign service, in opposition to the domestic airlines who (excepting United) declared for open competition overseas.



APPURTENANCES FOR BIGGER PUNCHES

To boost B-17 bomb capacity to a peak announced as 10 tons, external racks (arrows) are now fitted on our Boeing "Flying Fortresses."

The Washington Windsock

By BLAINE STUBBLEFIELD

Lawyers are given much of the blame for Washington being branded the "City of Utter Confusion." Some of the scores of applications before the Civil Aeronautics Board for new air routes, for example, are reported inspired by lawyers who visualize fat fees. The board makes no charge for filing an application, but the drafting of one of these documents is an advocate's dream. He can go on *ad infinitum* to prove that the region needs air service, and later on he hopes to prove—for another fee—that the airline needs a higher rate to survive.

Yes, they're all crazy about helicopters. And that also goes for such men as Grover Loening, technical advisor to the APB, and John Victory, NACA secretary. Loening says that almost every day he thinks of something new that can be done with a helicopter, and Victory is planning a direct-lift cruise with his son. The windmill is a hit, right across the board.

Public relations in Washington for aviation companies is one of the hardest jobs imaginable. You are put down for a lobbyist from the start, whether you lobby or not. The newspapers get mad because you don't talk, and the censor cracks down if you do. Committees ask you for information, brand it false, and print it in a report. Many have tried to do the job and a few have succeeded. Don't ask how.

Congressmen are impressed with facts they are getting on progressive decline of airmail and express service. Inspection shows that about nine-tenths of airmail deals with war business. And most express pieces are important. Some are vital to operation of production lines, departure of convoys, and so on, yet many are delayed because of the faulty cargo priority system. Passenger priorities have been granted between Chicago and Des Moines, leaving empty spaces all the way to the Coast. General conclusion is that shortage of planes and inefficient rationing of air services is impeding the war effort.

Some carriers have set up for themselves, with tacit approval of the Post Office, fixed mail load limits. If they have more, they throw it off, and lines reaching the same destination, which have no limits, are compelled to carry it, to the detriment of their other business. Carriers are thus expediting the mail at their own descretion. Of course, some are more conscientious than others. Post Office is getting in bad—with the Army for not developing a mail preference system, with the airlines for not exercising impartial authority, and with the public for selling air stamps and not flying the mail.

England, Sweden, and other airline operating countries, are looking for equipment in the United States. If the Administration lets them have it, a mighty howl will go up from airline operators and not a few Congressmen.

Cancellation of Higgins' contract for C-76 wood cargo planes was no surprise to those who remember that the Army made the deal under public pressure for a war-cargo-by-air program, also under virtual orders from the President, on whom Higgins did a sales job. With the need for airplanes increasing by the hour, the Army may take a notion to call for a halt on Kaiser's air freighters under construction at San Francisco. They are burning up a lot of engineer and worker hours.

Newest thing in glider warfare is to tow the craft behind combat planes which can attack any interference in the air or on the ground. Gliders will be designed to make high speed dives to shorten the period of attack upon them.

★ Military Memos ★

Fifty-nine percent of those questioned who could define the meaning and functions of a separate air force were found by a recent Gallup poll to favor such a force, while 41 percent voted against the plan. Navy Secretary Knox meantime is reported opposed to establishment of an independent air force, whereas support for the idea has been recognized in branches of the Army.

"The Army now has a new 4.7-in. anti-aircraft gun which can fire accurately to 60,000 ft., 20,000 ft. beyond the range of any other gun now in service," according to a statement by Maj. Gen. G. M. Barnes, as quoted in the **Army Ordnance Bulletin.**

It is reported that Wright Field men have questioned the precise accuracy of information that Col. C. S. Hough surpassed 780 mph. in two high-altitude dives (in a P-38 from 43,000 to 18,000 ft. and in a P-47 from 39,000 to 18,000.). The estimates were stated to be related to the speed of sound, and it is pointed out that due to sonic speed decreasing as altitude increases, determination of exact speeds at high levels is difficult. However, it appears evident that the Colonel broke former dive records.

One of the first officers to fly one of the original B-17's, Maj. Gen. Barney McK. Giles has succeeded Maj. Gen. George E. Stratemeyer as chief of air staff. Gen. Stratemeyer has been given command of combined India-China operations.

Command of the Eighth Air Force Bomber Command has been given to Brig. Gen. Frederick L. Anderson, 37, pioneer in development of bombardment tactics.

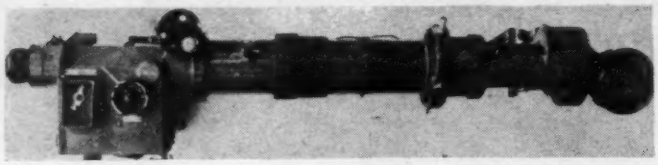
July over Naziland: RAF drops 20,000 tons of bombs. Americans bring total for month up to an estimated 26,000 tons, increasing their loads over June 50 percent and destruction of enemy fighters 75 percent, or more than 500 certains. Our heavy bomber losses put at 108. "Germany is beginning to bleed internally," says Brig. Gen. Haywood S. Hansell, Jr. Hamburg caught more bombs in little over a week than London in eleven months 1940-41.

Fourteenth (Chennault) Air Force records 9 to 1 score against Japs in 13 months: Enemy losses in air 312, on ground 130, probably destroyed in air 166; U. S. losses (excluding accidents) in air 36, on ground 15. During July the Fourteenth sunk 41,000 tons of shipping, damaged 35,000 more.

Chinese are reported using picric acid from dud Jap bombs to dye blankets.

36th AAF Birthday

Army air service, which recently celebrated its 36th birthday, began as a section of the Signal Corps in 1907 with one captain and two enlisted men. Today this number has swelled to nearly 2,000,000 pilots, bombardiers, radio operators, navigators, and technicians. The commanding officer, Gen. H. H. Arnold, learned to fly as a 2nd lieutenant in the days when it was an event for a plane to reach 5,000 ft. "We are established now in bases all around the world," Gen. Arnold says: "Our aerial lifelines are secure; men and machines are on the move in ever-increasing numbers." In the first seven months of this year, he revealed, AAF men have made 100,000 flights over enemy country.



Press Association Photo

JAPANESE BOMB SIGHT

First photo of Jap bombing device, captured in Attu campaign. Eye-piece and adjusting controls are seen on extreme left. This collector's item was marred only by a bullet hole just left of center.

★ Calling Names ★

Gill Robb Wilson has been re-elected to his fourth term as president of National Aeronautic Assn.

Ralph J. Cordiner, formerly with WPB, has been named assistant to the president of General Electric.

United Aircraft's board of directors has authorized important changes as follows: **Eugene E. Wilson** has been appointed vice-chairman, and in addition he will retain his present position as president; **Raycroft Walsh** has been named a member of the executive committee of United in addition to retaining his duties as its senior vice-president; and **H. Mansfield Horner,** newly designated vice-president in charge of manufacturing, will coordinate activities of all the divisions while continuing his duties as general manager of the Pratt & Whitney division. An operating and policy committee has been constituted and composing it are the three above-named together with **J. F. McCarthy** and **F. B. Rentschler.**

The recently formed Supervisors Club at Brewster has elected the following officers: **Richard J. McBride,** president; **George Compter,** vice-president; **C. D. Sloat,** treasurer; and **H. Hoffman, Jr.,** secretary.

George M. Muschamp and **Paul L. Goldstrohm** have been appointed vice-presidents of Brown Instrument, subsidiary of Minneapolis-Honeywell Regulator.

Capt. Edward Orrick McDonnell, USNR, recently was announced as new chief of staff of the Naval Air Training Center at Corpus Christi, Tex.

George R. Murray and **Edgar S. Hutton** have been elected vice-presidents of Chambersburg Engineering. Respectively they are also works manager and treasurer.

To **Capt. John B. Wilson,** on leave of absence as pilot of UAL, has gone the DFC for extraordinary achievement with the AAF overseas.

Robert R. Ranslem has been appointed assistant chief technical engineer of Aircraft Industries. Other recent appointments saw **E. M. Chudley** named as administrative assistant and **Harry C. Donoho** as editorial director.

John P. Gaty, vice-president and general manager of Beech Aircraft, has been named to the Board of Governors of the Kansas City Region of the Smaller War Plants Corp.

Ryan Aeronautical has named **W. Frank Persons** head of its newly-organized industrial relations department; **Oliver Frazer, Jr.,** is now industrial engineer; and **Paul Hugh Waldman** is new liaison representative at Wright Field, with **Kirk Sellew** succeeding him as Ryan field service representative. **Miss Betty Mills,** r. n., is the company's new visiting nurse.

Arthur Foristall, representing Hill & Knowlton, public relations counsel, as director of public relations of Consolidated Vultee, San Diego, has been made resident partner of the firm.

General Aircraft announces that all of its directors and officers have been re-elected. They are: Chairman, **W. S. Orr;** directors, **H. J. Maynard, Jr., J. T. Geuting, Jr., O. C. Koppen, Harry L. Kirkpatrick, Harris Fahnestock, Jr.;** officers, **E. S. Greamse,** treasurer; and **K. Ian Deane,** secretary. Messrs. Maynard, Geuting, and Fahnestock are president and vice-presidents, respectively.

Charles D. Truman has been appointed public relations director of Interstate Aircraft.

Recent additions to the editorial production and executive personnel of the Princeton Film Center include **A. E. Milford** and **Leroy G. Phelps,** formerly with the domestic film production unit of OWI, and **Gates Ferguson,** formerly with N. W. Ayer's public relations staff.

Harry L. Smith has been named vice-president and general sales manager of Kelite Products. Other appointments: **Bruce Wiswall,** in charge engineering division; **C. L. Gilmour,** Southern California regional manager; **Leon Alexander,** general manager of Houston, Tex., plant; **Lyle Harbour,** Arizona-New Mexico regional manager; **R. E. Medanich,** Northern California regional manager; **Ernie Severseen,** North West regional manager; and **William Van Patten,** control chemist, Los Angeles Laboratory. **M. L. Forsberg,** Midwest regional manager, will now have headquarters in St. Louis, where a new office has been opened. Meanwhile, **J. H. Hart,** chief chemist, has returned from a tour of Eastern war plants where he studied cleaning and processing operations.

Obituary

Among those lost in recent glider crash in St. Louis was Maj. William B. Robertson, who founded in 1918 the company which bore his name and which had made the craft. He was also the first man to land a plane at Lambert-St. Louis Field, where the accident occurred.

Lost in a crash of an American Airlines plane in Kentucky were W. K. Cooper, sales vice-president of The Aviation Corp.; Harold Caminez, chief liquid cooling engineer of the corporation's Williamsport Lycoming Div.; and R. H. Anderson, business manager of Consolidated Vultee's Nashville Div. Their deaths were the first reported in 60,000,000 mi. of passenger operation by the domestic air transport carriers.

Deceased after several months' illness is Montgomery Knight, helicopter design authority and director of Daniel Guggenheim School of Aeronautics of Georgia School of Technology.

News is also received of the death from a heart attack of Roscoe Wright, who had recently been reappointed CAA Director of Information and Statistics, a post he resigned in 1941 because of ill health. Mr. Wright was 43 years old.

Manpower Shortage

(*Continued from p.* 267)

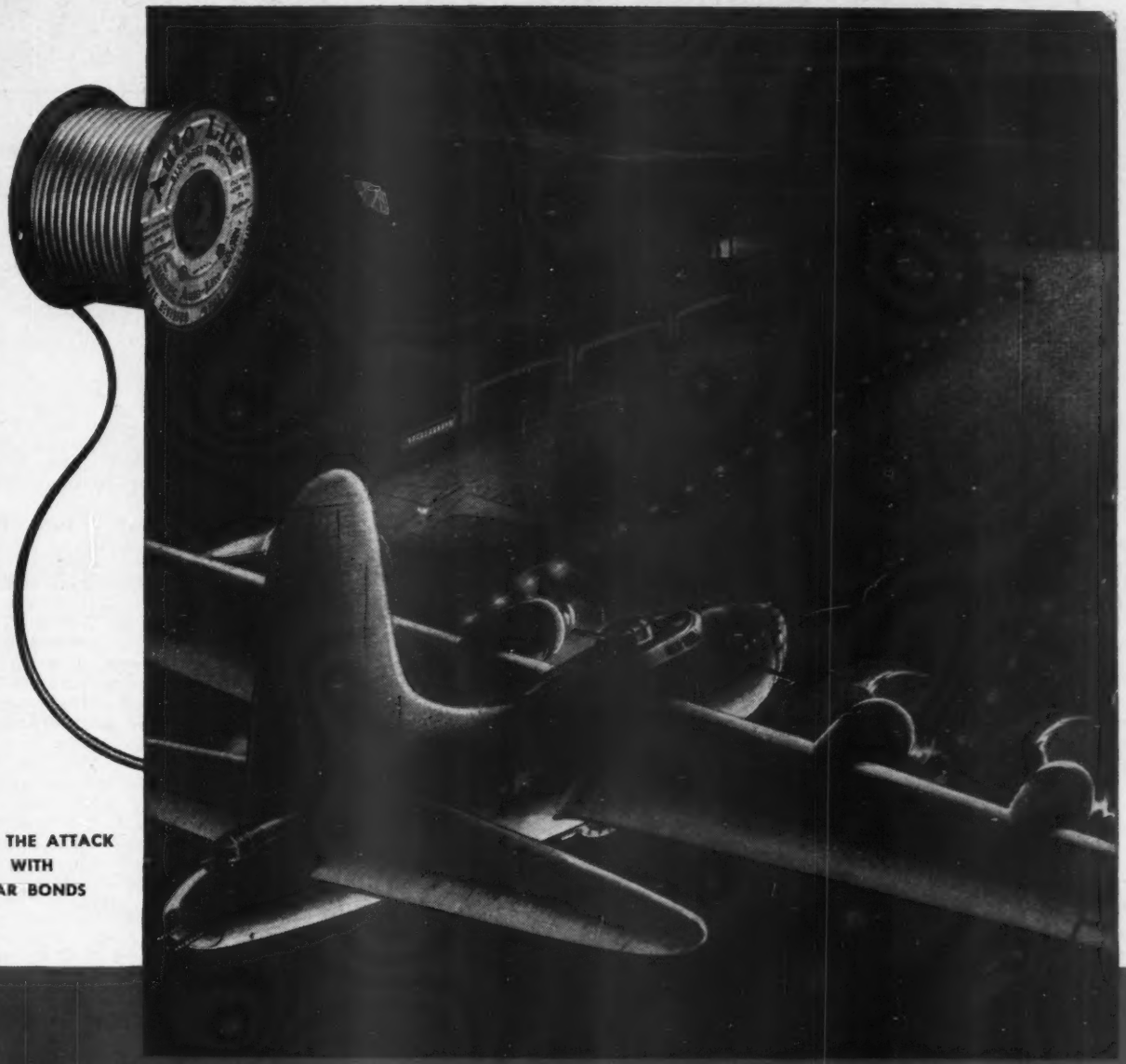
frame plants vulnerable to induction. This includes 37 percent of engineering personnel, 24 percent of the tooling employees, and 28 percent of the inspection forces. Under the first replacement schedules, the plants would have lost 16,000 men in the second six months of 1943. Now, under the new "second replacement schedule," an additional 5,000 men will be lost in the same period.

In Jan., 1943, the personnel deficit was 1,303. By April it had increased to 27,388. In June it dropped to 19,018 due to the influx of approximately 5,000 students and teachers available for the summer only.

Donald Douglas said flatly that if his company loses the engineering personnel vulnerable to induction it will be impossible to continue new design engineering and likely that the department will not be able to keep up with even the necessary changes constantly being ordered by the air forces.

Testimony of other plant representatives backed up the Kindelberger outline with personnel figures, all of which indicated that if Selective Service continues to drain away key, supervisory, engineering, and inspection personnel, aircraft and parts production in West Coast plants will be reduced, in some instances in the parts plants as much as 50 percent.

T. T. Arden, president of the Aircraft Parts Manufacturers Assn., testified that from a survey made within the 24 hr. previous to his appearance before the committee that 124 plants are already behind schedule an average of 20 percent.



BACK THE ATTACK
WITH
WAR BONDS

Lighting the "War Bird's" home!

The end of a mission may hold its most tense moments. Landing fields are precious. Positions must not be revealed. Often the pilot must land with the merest flash of light.

The most dependable performance is needed from plane landing and signalling lights, from instrument and radio set-ups, too. This overall performance can be no better than the wire on which it depends. Auto-Lite engineers have helped through the development of various types of wire and cable that are required for aviation lighting, for instrument and radio operation, for many phases of Army-Navy aviation requirements.

Information on Auto-Lite aircraft wire and cable should be in your file. Form No. 838 covers low tension wire and cable. Form No. 666 gives complete details about Steelductor, the high tension wire that is famous for better performance, and economy. A request on your letterhead will bring both Bulletins.

PORT HURON, MICH. **THE ELECTRIC AUTO-LITE COMPANY** SARNIA, ONTARIO
Wire Division

AUTO-LITE AIRCRAFT WIRE and CABLE

IN ITS 26 GREAT MANUFACTURING DIVISIONS, AUTO-LITE IS PRODUCING A LONG LIST OF ITEMS FOR AMERICA'S ARMED FORCES ON LAND, SEA AND IN THE AIR

Aviation Manufacturing

Burden Favors Government Assistance In Future Promotion of Private Flying

In the opinion of William A. M. Burden, special assistant to the Secretary of Commerce, the government should participate in the development of private flying, which he terms "the most promising field" of sales for the manufacturing industry whose postwar business, he feels, can be only "a small fraction" of present volume.

Speaking before the Los Angeles Chamber of Commerce, Mr. Burden estimated that yearly sales of 100,000 private planes at $2,000 each would result in business "twice as great as the probable annual replacement sales of transport aircraft in the domestic United States in the immediate postwar period."

Government financial assistance to develop this market, he said, should be directed at producing private planes which are useful, inexpensive, and safe. Three types, he states, will probably be needed: (1) a fast, highly maneuverable craft for businessmen and professional flyers which will carry four or five people between 180 and 250 mph.; (2) a safe, low cost, easy to control "rocking chair" model for the family cruising between 110 and 135 mph.; and (3) a "helicopter, or some adaptation of that principle."

While the development of planes is the responsibility of the industry, Mr. Burden listed the tasks of the government as securing "priorities for the construction of a few experimental types as soon as the status of the war permits," adaptation of traffic controls to handle postwar private flying volume, investigation of possible construction of a "substantial number of small airports in metropolitan areas."

"There are also," Mr. Burden said, "sound arguments for continuing federal assistance to flight training."

Report New Facilities And Production Records

Expansion of manufacturing facilities have been undertaken by three companies, and others announce new production records for recent periods.

Packard Motor Car Co., which doubled its greatest annual peacetime volume in the first six months of this year, has acquired the Toledo plant formerly occupied by the Aviation Corp. Occupancy has already begun and "several hundred parts now machined by Packard in its Rolls-Royce aircraft engine program will eventually be processed in the Toledo plant," according to Pres. George T. Christopher. The move, made to meet increased engine output required by the Army, is estimated to involve a $10,000,000 annual payroll "and business volume is expected to top a monthly 7-figure total." Full plant capacity, Mr. Christopher said, "is expected to be reached before 1944."

Firestone Aircraft Co. has purchased the plant and equipment of G & A Aircraft, Inc., at Willow Grove, Pa., and obtained license from Autogiro Co. of America to 200 patents on rotary wing aircraft. G & A succeeded to the business of Pitcairn Autogiro Co. "The licensing of the Autogiro Co.'s fundamental patents," said Pres. Harold F. Pitcairn, "is intended to promote, at the lowest cost to the government, their maximum use for military purposes."

Production for the first half of this year as compared to the same period in 1942 was reported doubled by Aro Equipment Corp. and by the Aviation Corp.'s Republic and American Propeller subsidiaries. Aviation's Lycoming engine division announced a gain of 32 percent in dollar volume for the comparative six months. As July production of B-24's at Convair's Fort Worth plant exceeded schedule, it was announced that Goodyear will modify *Liberators* at Tucson into land-based bombers for the Navy. They will be designated PB4Y-1. Beech's first-half production was greater than for fiscal year of 1942.

Glider output at the Long Island plants of General Aircraft is announced to be at an all-time peak; work is being confined to CG-4A's.

New Exhaust De-Icers On Consolidated Planes

Cooperation between NACA and Consolidated Vultee has resulted in the development of an engine exhaust de-icing apparatus which is being installed in *Liberators, Catalinas,* and *Coronados* and which will also be used on other planes. It is said to add no additional weight.

Scoops on engine nacelles catch air and circulate it around a heat exchanger. Heated air then travels in several directions—chordwise through center section feeder ducts; spanwise, escaping through vents in the outer panel leading edge duct; then through the inside of the wing. Discharge is made aft of the rear spar.

In warm weather, heat from the exchanger can be discharged overboard. Auxiliary tail units have been designed for *Catalinas* and *Coronados.*

Toolmen Turn to Aircraft

Machine tool requirements are declining rapidly, and the War Production Board, in consultation with the industry, is converting unused tool capacity to the production of other war material. Among aircraft items considered suitable for manufacture by tool plants are superchargers, hydraulic systems, pumps.

PRODUCTION-BATTLE CITATIONS

During the first year of joint presentations only 1,910 plants and projects have received Army-Navy "E's." This number is estimated to be less than 2½ percent of those eligible. Recent star winners and flag recipients are:

★ One Star ★

ALUMINUM INDUSTRIES, INC.
BONNEY FORGE & TOOL WORKS
ELECTROMASTER, INC.
U. S. RUBBER CO.
(Mishawaka, Ind., plant)
N. A. WOODWORTH CO.

Army-Navy "E"

AERONCA AIRCRAFT CORP.
AMERICAN VISCOSE CORP.
BENDIX AVIATION CORP.
(Julien P. Friez & Sons Div.)
CANNON ELECTRIC DEVELOPMENT CO.
CINCINNATI GEAR CO.
COPPERWELD STEEL CO.
GENERAL ELECTRIC CO.
(Plastics Div.)
GILLETTE SAFETY RAZOR CO.
LINK-BELT CO.
REPUBLIC AVIATION CORP.
WESTERN GEAR WORKS
WESTINGHOUSE ELECTRIC & MFG. CO.
(Meter Div. and Mansfield, Ohio, works)

AWS Annual Schedules Three Aircraft Programs

Three aircraft welding sessions are included in the program of the 24th Annual Meeting of the American Welding Society scheduled for the week of Oct. 18 at the Hotel Morrison, Chicago. Time of meetings and subjects:

Oct. 20, 9:30 a.m.—Fatigue Strength of Welded Aircraft Joints, The Spot-weldability of Low Carbon and Other Aircraft Steels, and Weldability Tests of Aircraft Structural Steels.

Oct. 20, 2:00 p.m.—The Heli-arc Welding of Magnesium Alloys as Used in Airplane Fabrication and Substitution for Critical Materials, Fatigue Studies of Welded Test Triangular Structures With NE-8630 Steels, Fabrication and Welding of Aircraft Exhaust Tubing-Manifolds and Headers, and Arc Welding X4130 Aircraft Tubing.

Oct. 21, 9:30 a.m.—Quality Control of Aircraft Spot Welding, The Application of Flash Welding in Airplane Construction, Spot Weld Joint Efficiency for Aluminum Alloys, and Spot Welding of Magnesium Alloys.

Curtiss C-76 Cancelled; To Increase C-46 Output

Army has cancelled a Higgins contract for Curtiss-Wright C-76 wood cargo planes. A Higgins yard near New Orleans was being converted to produce the planes.

Production of the C-76 was also stopped in the Curtiss-Wright plant at Louisville, Ky. G. W. Vaughan, C-W president, said that the need for this type no longer exists. The Louisville plant will be converted to the Curtiss C-46 *Commando,* world's biggest two-engine all metal cargo plane. The C-76 was approximately the size of the DC-3.

One of the main reasons for the wood construction of the craft was shortage of strategic metals, particularly aluminum. "Aluminum has since become plentiful, but there is now a shortage of plywood.

To Develop Rotary Craft

New research and developments in the rotary-wing field have been initiated by RotaWings, Inc., recently organized with offices in New York and Philadelphia. Agnew E. Larson is president.

Martin Developing New Cargo Plane

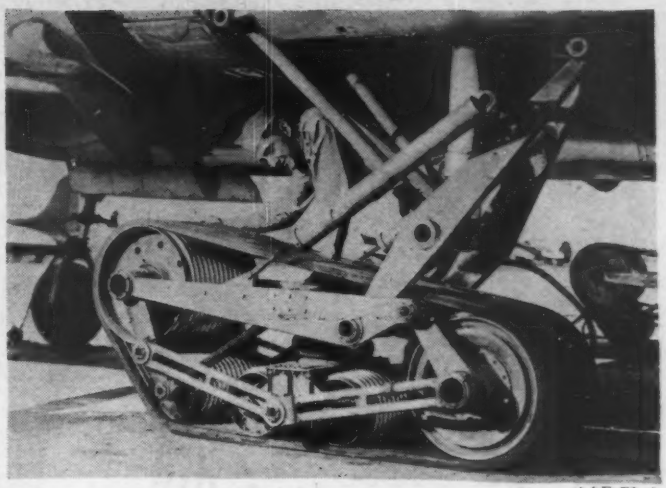
Glenn L. Martin is developing a new cargo plane following designs by William D. van Zelm of the company's engineering department. One version is powered with two engines, another with four. Both have tricycle landing gears. Tail assemblies are on twin extensions of the engine nacelles so that the aft end of the fuselage is free to open for loading. The hydraulic mechanism used to raise the cargo door also extends a collapsible loading ramp, adjustable to either the ground or a platform. Furthermore, adjustable jacks under the ramp sustain weight of freight during loading. A winch has been incorporated in the design to make the plane independent of field load-handling facilities.

Gross weight of the two-engine plane is to be 60,000 lb., 20,000 lb. heavier than the PBM-3 *Mariner*. The four-engine version is to have a gross weight of 86,000 lbs. and a useful load of 36,870 lbs. of which 27,000 are for cargo. Other versions are under consideration.

ASTM Okays Data, Tests

About 50 specifications and tests were approved at the recent 46th annual meeting of the American Society for Testing Materials held in Pittsburgh.

Dean Harvey, Westinghouse, will serve as president for 1943. J. R. Townsend, Bell Laboratories, is vice-president. The Charles B. Dudley medal for 1943 went to Walter Bonsack, National Smelting Co., for his paper. on aluminum casting alloys.



AAF Photo

TO SMOOTH ROUGH "SET-DOWNS"

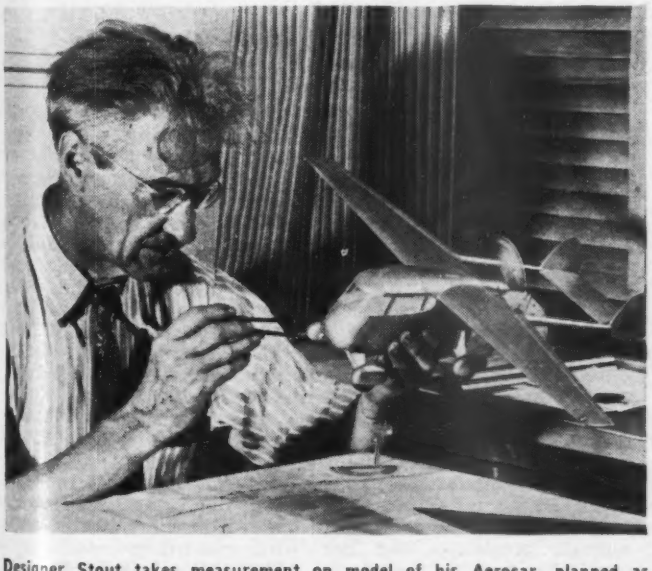
Being tested at Wright Field, this caterpillar gear for landing on rough or soft ground contains about the same amount of rubber as a regulation tire but provides four to eight times the contact area. It is hung on steel bracing and rubber track, with suspension mechanism to absorb shock, has wire-beaded edges which fit into grooved aluminum bogie wheels. Firestone engineers, who developed gear along with Army Aircraft Laboratory and Dowty Equipment Co., report landings at 120 mph. This installation is on an A-20. Meanwhile, it is thought possible to make this type of gear for smaller planes.

Postwar Private Planes Begin Hatching With 3 Models by Convair's W. B. Stout

Announcements of new designs of family aircraft, personal planes and direct lift machines are multiplying. Roadable flying cars and refinements of helicopters are in development by many companies looking to establishment, after cessation of hostilities, of a market for mass-produced small aircraft.

William B. Stout, head of Consolidated Vultee Stout Research Div., has designed three small craft for prospective postwar production. One is a 1,500-lb., four-wheeled flying car with folding wings and designed for 60 or 70 mph. on the road. The second is an 800-lb. roadable plane to be slower on the ground but faster in the air and rugged enough for light delivery service. Third is the *Helicab* with a 33-ft. rotor and fuselage of light steel and dural sheathed with a new plastic. With a conventional 125-hp. engine, two passengers, and baggage, it will weight about 1,700 lbs. Stout is developing a simplified mechanism for changing the angle of the rotor blades.

The growing effort to popularize family aircraft centers around simplification of controls, according to Albert A. Vollmecke, chief of the Aircraft Engineering Division of CAA. One concern is working on the possibility of lowering cost of engines from $5 to $2.50 per horsepower.



Designer Stout takes measurement on model of his Aerocar, planned as 1,500-lb. "flying automobile." Projected is 100 mph. speed in the air and 60 to 70 on the road after wings and outrigger assembly have been removed.

Truman Writing Reports On Industry and Bases

Washington (AVIATION Bureau)—A Truman report on all phases of airplane production is in preparation and will be ready for publication shortly after Congress reconvenes in mid-September.

Members of the committee are visiting plants and modification centers in Birmingham, New Orleans, Dallas, Fort Worth, Kansas City, Omaha, and Chicago.

Their recent critical report was only an interim release. Most people agreed that its publication was of little use; all the information it contained was well known by the industry. Observers wait with interest to see whether the committee will present any revealing information in its forthcoming over-all aviation report.

Also to be published some time this fall will be a Truman report on American air bases and their supplies of parts, plants, fuel, etc.

Brass and Copper Eased

An advisory system to facilitate placing of orders with brass and copper mills has been announced by the non-ferrous sub-unit of the AAF scheduling unit, Steele High Bldg., Dayton.

Since mills are forbidden to accept orders, even under CMP allotments, when their capacity is filled, the non-ferrous unit and the mills are keeping weekly records of open capacities. Aircraft manufacturers unable to place orders will be advised of capacities available by the non-ferrous unit, which will place the order verbally for the manufacturer to confirm later.

New AAF Wind Tunnel

A wind tunnel which will generate velocities of over 600 mph. at temperatures as low as —67 deg. F. is now under construction at the Army Air Forces Material Command, Wright Field.

FOR THE RECORD

Douglas has delivered the first C-54 **Skymaster** from its Chicago plant just a year after ground was broken.

Seals of weight approval have been given by the SAWE to Adel Precision Products Corp., Burbank, Calif., for three of its control valves.

Kennametal, Inc., has succeeded McKenna Metals Co., Latrobe, Pa. Personnel, products, and policies will remain unchanged.

Bell Aircraft's ordnance div. is being moved to Burlington, Vt.

Emerson Engineering Co. has opened new plant and offices in Los Angeles 26.

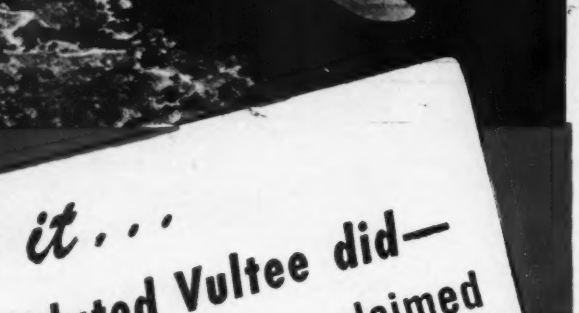
Westinghouse has undertaken promotion of uses of electronics through a new group of three engineers, G. F. Jones, C. J. Madsen, and A. J. Germain.

Arthur J. Norton, chemical consultant, has moved his offices to Seattle.

Aircraft Parts Manufacturers Assn. is now located in Chamber of Commerce Bldg., Los Angeles.

Executive offices of Jefferson-Travis Radio Mfg. Co. have been established at 235 E. 23 St., New York City 10.

Test it . . .
Consolidated Vultee did—
They found it all we claimed



THE LOXIT SKIN FASTENER . . . was recently tested by laboratory technicians at Consolidated Vultee Aircraft Corporation, builders of the famous Liberator B-24 Bomber. Results substantiated every claim made.

SAFER . . . special design and rugged construction adds increased safety factor. Appeals to women workers.

FASTER . . . simply line up skin holes . . . compress . . . snap and it's in.

EASIER TO USE . LOXIT Skin Fasteners need to be held in compression only at instant of application. Motion studies show this saves 75% of worker fatigue and speeds operation an average of 10%.

LONG-WEARING . . . hardened steel body shell and heat-treated plunger reinforced by tubular sleeve increases life span.

SMALLER . . . easier to handle in close quarters, particularly near right angle bends.

You test it . . .
they did . . .
and found it worth-while

FREE SAMPLES

A request on your business letterhead will bring you LOXiT Skin Fasteners for your testing. You'll find it fits any standard type pliers or gun. Write today.
Scovill Manufacturing Company, 20 Mill Street, Waterbury, Connecticut

LOXiT
SKIN FASTENERS
SPEED THE JOB
A SCOVILL PRODUCT

Transport Aviation

WPB Considers Giving Lines More Planes; Nearly Half of Mail Is Being Delayed

Washington (AVIATION Bureau) — Few people realize how airmail service has been disrupted by the war. Airlines say that "enormous" quantities of mail are being diverted to trains and seriously delayed on the ground. The Post Office Department, reluctant to admit a breakdown, infers that nearly half of all airmail is being delayed but gives no definite figures.

Several Congressmen, CAB, the Air Transport Assn., and others, have been trying to determine what action should be taken. The press and many mail users have reached the conclusion that airmail postal revenues should not be accepted when there are switches to train service, or other delays.

Action has been tardy because authorities and patrons dislike to molest the Army's air transport services. During recent weeks, however, some critics have said that the ATC has been using its planes inefficiently, allowing them to stand idle; that ATC has given preference ratings to many non-essential military travelers while war production officials marked time; and that the air express priority system is inadequate.

There are only 30 odd clearance centers as compared with nearly 1,000 for priority passengers, yet the number of express patrons outnumbers passengers about ten to one.

WPB is seriously considering the allocation of more planes to the airlines in the near future. ATC realizes that poor mail service is impeding the war effort. The airlines say that about 20 large transports would enable them to carry the loads. Informed persons say the Army may return 165 planes.

Record Loads Carried

Reports prepared by various operators for the first half of the year indicate new passenger, mail, and express records. Estimating June figures, United reported revenue passenger miles up 15 percent over the first six months of 1942; express pound miles increased 13 percent and mail pound miles 82½ percent. The passenger total on Northeast Airlines gained 13 percent over last year's first half. Pound miles on American were up 97.4 percent, airmail poundage 89.2 percent. Six months' figures released by TWA showed mail up 100 percent, express 78 percent, and revenue passenger miles 9 percent over Jan.-June, 1942, despite a 16 percent decrease in revenue miles.

Subsequent to these reports Railway Express Agency announced a 12½ percent basic reduction in air express rates.

CAB to Report On Feeder Airlines

A report on the national need for feeder airlines may be expected from CAB soon, L. Welch Pogue, Board chairman, says the time has come to develop a system of small lines linking up with the big ones and providing service for towns and small cities. Applications are now on file which, if granted, would serve 3,000 towns in 31 states over 54,000 route miles.

Mr. Pogue said that the feeder system will need special smaller aircraft. Helicopters, he said, cannot take the whole burden of feeder services; other types of craft will be needed as well as about 1,000 more airports. Thus far, he continued, we have 3,000 of the 4,000-port program projected before the war.

Part of the cost of expanding services to smaller cities, Pogue believes, will have to be borne by the federal government. One trip a day on 50,000 more miles of pick-up services would cost the government about $18,000,000 a year, he estimates.

Route Applications Submitted to CAB

Chicago & Southern: Houston via Tampico to Mexico City.

Northeast: New York City and Newark to Pittsburgh, New York City and Newark via Binghamton, Buffalo and/or Niagara Falls, Erie, Pa., Detroit, and Grand Rapids to Chicago, also the same run with stops at Atlantic City, Philadelphia, Harrisburg, Pittsburgh, Akron, Cleveland and Toledo.

Western: San Francisco via Sacramento and Portland to Seattle.

Delta: 3,500 new route miles touching 24 additional cities in eight more states including extensions reaching New York, Miami, Kansas City, and a new route from Cincinnati to Norfolk.

American: Route extension from Syracuse to Ottawa. Routes between Detroit and Cleveland, Detroit and Miami, Chicago and Milwaukee, Chicago and Minneapolis-St. Paul, and extensions providing for service between Columbus, Toledo, and Detroit, Nashville and New Orleans, Philadelphia and Allentown, Pa., and Chicago to Washington and New York. On existing routes stops have been requested at Joplin, Mo., Binghamton and Elmira, N. Y., Wilmington, and Richmond.

Braniff: Oklahoma City, via Tulsa and Memphis, to Atlanta.

TWA: Inclusion of Wilmington as intermediate stop on Philadelphia - Harrisburg run.

Penn-Central: Washington and Baltimore, via Wilmington, Philadelphia, Trenton, and Newark, to New York; New York nonstop to Boston, and New York, via Bridgeport, New Haven, New London, New Bedford, Fall River, Providence, Attleboro, Taunton, and Brockton, to Boston; also via New Britain, Waterbury, Meriden, Bristol, Hartford, Springfield, and Worcester, to Boston.

Helicopters: Southwestern Greyhound Lines — air-bus service on five routes in Arkansas. Asbury Park-New York Transit Corp. — New York City to Jersey coast. Beiner Auto Service—New York City to north shore of Long Island. Grand Island Transit Corp. — Buffalo to Niagara Falls. Frisco Transportation Co.—Service in Missouri, Arkansas, Oklahoma, Texas, Kansas, Tennessee, Mississippi, Alabama, and Florida.

Patterson Explains UAL Foreign Policy

Los Angeles (Special to AVIATION)—Postwar visions of expansion of air transport and aviation generally were deflated by W. A. Patterson, president of United Air Lines, in a speech before the Rotary Club here. He predicted considerable expansion but said it would not be as great as some people imagined.

In response to inquiries regarding United's refusal to sign the foreign policy agreement recently drawn up by 16 other U. S. airlines, he explained that his company was actually in full accord with the agreement but wished it to contain another proposal. United's proposal recommended that all overseas air routes be operated by one U. S. line which would be owned jointly by all domestic lines.

Pres. Patterson asserted that United foresees reciprocal agreements on landing rights. In view, he said, of foreign airline ownerships and subsidies, it is his belief that the United States' bargaining position will be stronger with only one overseas line.

On the domestic scene, he predicted that the airlines will take over 80 percent of first class passengers going 300 mi. or more, but he said they will have to reduce rates 25 to 30 percent below recent reductions; all first class mail and parcel post will be hauled by air after the war if rates are cut 50 percent. To carry about 40 percent of express, that classed as light or perishable, rates will have to be lowered 500 percent.

Postwar air transport, Mr. Patterson estimated, will require about 5,250 planes, a large percentage of them of the 60,000-lb. class. They will handle, he calculates, 3 billion ton-miles of business, leaving 537 billion ton-miles for the surface lines, which offer no competitive threat.

To Study Air Policy

The Chamber of Commerce of the United States has formed a committee of air and shipping executives to recommend basic national policy for the conversion of the nation's air and shiplines into permanent postwar systems. Of primary importance, says Chamber Pres. Eric Johnston, will be the adoption of policies to "promote the fullest development of competitive enterprise within and among all peoples."

Airline officials on the committee are J. C. Cooper, PAA; Ralph S. Damon, American; P. G. Johnson, Boeing; W. A. Patterson, United; J. E. Slater, American Export Airlines; J. A. B. Smith, Curtiss-Wright; and S. J. Solomon, Northeast.

All-Cargo Service Begun

First transcontinental all-cargo air service has been inaugurated by American Airlines with daily flights between New York and Los Angeles. Stops for mail and cargo but no passengers will be made at Washington, Nashville, Memphis, Dallas, Fort Worth, El Paso, and Phoenix. Flights will be made in the line's *Flagships* (DC-3's). Special containers, which convert seats into cargo space, will double mail and express loads of passenger flights.

ATC'ers Organize Line

After World War I, initial air transport businesses were organized by pilots, and now Trans-Ocean Air Lines, Inc., organized by Capt. T. G. Smith and a number of other ATC flyers, is planned. Registration is for 300,000 shares of class A voting stock without par value. Initial offering is to be 250,000 shares at $1 to participating personnel.

Mal d'Air Decline

Surveying the flying reactions of 2,248,998 passengers carried from 1936 through 1942, United Air Lines reports that air sickness has declined from 3.3 passengers to only one per 1.000.

★ CROSS COUNTRY ★

Program of the 16 signatory domestic airlines for postwar air transport (p. 274 Aug. AVIATION) was presented to the President Aug. 10. It is expected that the government's postwar policies on international aviation will be projected at a British-American conference to be held in the fall. . . . CAB Member Josh Lee has suggested that the CAB might name a committee to consider the desirability of having more U. S. air terminals owned by airlines rather than municipalities. He also advises formation of a joint committee of State, Treasury, and CAA representatives to simplify immigration, customs, and currency regulations in order to expedite international air transport . . . American Export Airlines has dedicated its new $1,000,000 7½-acre marine base at LaGuardia Field, New York.

Cost of compulsory insurance for flights over Mexico has been absorbed into the price of the ticket by PAA . . . Construction of a commercial airport at Grand Island, N. Y., as a postwar public works project has been recommended by the Niagara Frontier Postwar Planning Council . . .

W. A. Patterson, UAL president, predicts 80 percent of first-class passengers will some day travel by plane at rates 25–35 percent lower.

Virginia State Corporation Commission has granted a charter to Dominion Airways to operate five routes in the state and permission to W. M. Edmondson to operate a second airport with two 2,500-ft. runways near Lynchburg where Army cadets will be indoctrinated. The Commission has also received an application for the organization of Central Airlines, which plans peacetime service radiating from Lynchburg.

Continental has resumed service to Sante Fe with the opening of a new terminal . . . Conversion of Commonwealth Airport, East Boston, into a modern field of four 5,000-ft. runways has been authorized by Gov. Saltonstall with the signing of a $4,750,000-appropriation.

Service has been resumed by American Airlines to Palm Springs, Calif., for priority passengers and express and non-priority travelers and cargo originating or destined to Fort Worth and beyond. No mail will be carried.

PAN AMERICAN OPENS NEW WESTERN TERMINAL

Consuls of 20 Latin American republics and Calif. Gov. Earl Warren take part in dedication of PAA building at Lockheed Air Terminal, Burbank. Terminus of company's Los Angeles-Mexico City route, it contains port-of-entry offices of U. S., Mexican, and Central American customs, also operations quarters for PAA and its subsidiary, Cia. Mexicana de Aviacion. Meanwhile, PAA's acquisition of 40 percent of stock of Aeronaves de Mexico, S. A., has been called a controlling interest by a CAB examiner who indicates that a hearing will be held to determine the transaction's public interest.

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Aviation Abroad

Cripps Sees British Postwar Production 1-10th Present Rate; Transports Ordered

Sir Stafford Cripps, British Minister of Aircraft Production, states that probably not more than one-tenth of the present rate of airplane production will be maintained in England after the end of the war.

He also says that the comparative efficiency of the various aircraft firms will decide where this one-tenth will be made. And the fact that government control of certain aircraft manufacturing concerns was mentioned in the same breath leads many to believe official British circles plan at least one large government owned and controlled aircraft plant after the war.

That some definite attention is now being given to Britain's postwar air transport status is evidenced by recent Ministry of Aircraft Production orders to four leading manufacturers, calling for designs for postwar aircraft. While a long war may well see these aircraft in production for military needs, even though specifically designed for commercial use (witness the conversion of Lockheed's *Constellation*), it is generally felt that this is the first step toward an adequate commercial air transport fleet. At the present time, only the converted *Lancaster* bomber and such DC-3's and C-87's as can be spared are available for commercial use.

The four firms from which new designs were requested are Bristol, Handley-Page, Short Bros., and deHavilland. Short Bros. is known to be working on designs of a giant flying boat with normal range of 4,000 mi. and space for 200 passengers on "short hops" of 600-750 mi.

U. S. Transport Craft Sought by Swedish Line

Swedish Intercontinental Air Traffic, Inc., mentioned some time ago as a new contender on the after-the-war transocean flying front, has now reached the stage where P. A. Norlin, an executive, has come to the U. S. to attempt to obtain equipment for its operations.

Norlin, formerly with the Swedish A.B.A. airline, announces that agreements have been reached with the A.B.A. along lines provided for by the International Air Traffic Association allowing Swedish Intercontinental to operate services outside the European continent, with only a connecting line to Sweden's capital. Meanwhile the A.B.A. will continue to operate all domestic and European services. Swedish Intercontinental further will receive from the A.B.A. reciprocal representation rights in traffic matters.

Norlin states that the development of Swedish Intercontinental is dependent upon postwar rights to fly to other countries. He points out that Sweden has always maintained a reciprocity program for foreign airlines and further advocates complete freedom of the air, with only basic agreements between nations.

The airports at Stockholm and Gotheborg, considered among the most modern in Europe, have been expanded to accommodate the four-engine planes S.I.A.T. expects to operate. A.B.A. has always operated with foreign aircraft, including Douglases, Fokkers, Junkers, and Focke-Wulfs. No change in this policy is expected, since Sweden does not have any heavy airplane industry.

★INTERNATIONAL BRIEFS★

Through American lend-lease, the Netherlands Government in Curacao has obtained two Lockheed C-60A *Lodestars*. To be flown by KLM pilots, they are expected to be used on the Curacao-Miami run.

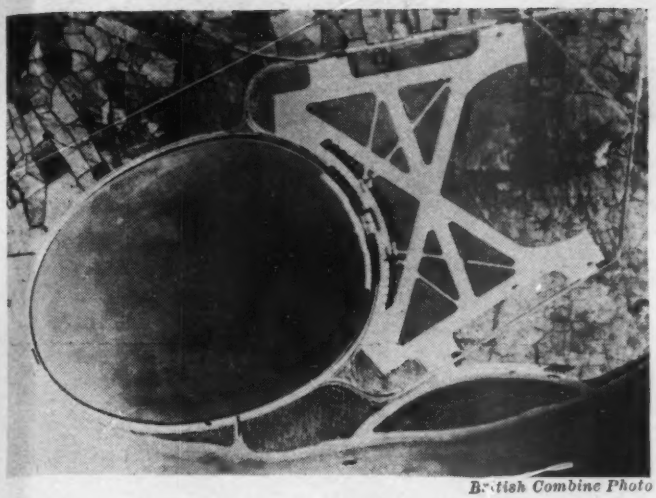
Reports state two Mexican plants are now in production on Mexican Air Force planes. And the magazine *Todos* hints at the possible transfer of an American factory to Mexican territory.

Air travel insurance may now be purchased at Canadian Pacific Air Lines offices at $1 per $20,000 worth. Travel in any part of the North American continent and the West Indies is covered.

That representatives from all parts of the British Empire immediately begin drafting a postwar air commerce policy is urged by Viscount Bennett, former Canadian prime minister. He warns of a potential commercial defeat unless policy action is quickly forthcoming.

Mileage Totals Reported On Latin American Lines

Great progress made by Latin American airlines is



British Combine Photo

PLAN FOR LONDON AIRPORT OF TOMORROW

Model of postwar airport for London has lagoon (left) with access to Thames Estuary for flying boats, and land plane runways 2½ mi. long. Between them are main buildings with hotel, restaurant, theater, and railroad station. Designed to handle 8,000,000 passengers yearly, field would cost about $80,000,000.

shown in the recent Department of Commerce report on civil aviation in Central and South America.

Total mileage of the 44 operating companies is revealed as 106,828, compared with the 47,700 mi. in the United States, and scheduled stops total 750 as against 260 in America.

Of the ten leading South American airlines, five are divisions or satellite companies of PAA, which controls more than 50,000 of the route miles flown by all companies.

In total scheduled miles flown, PAA and affiliates account for 62.4 percent; the remaining 39 companies divide the balance of 37.6 percent.

On Schedule . . . by "Vista"

BOAC, now operated under a new management and more or less under the British ATC auspices insofar as it concerns international routes, seems to have profited by the new arrangements in at least one way—badly needed new planes have been given the company. Recent pictures from England show both DC-3's and C-87's carrying British commercial markings. Furthermore, BOAC has opened a regular Britain-Moscow service. The route, somewhat circuitous and taking 3½ days to cover is via Lisbon, North Africa, Cairo, Irak, Iran, Astrakan, and Kuybyshev.

Reports indicate the virtual collapse of Italy's airline system, both inside the country and on its routes to Spain, Germany, and the Balkans. Both the Rome-Barcelona-Lisbon service and the new line to Roumania have been suspended until further notice. True, services between Rome and the North Italy cities were still running occasionally at this writing, but without any kind of schedules.

This column once mentioned that the government's Defense Supplies Corp., had bought up some Axis planes stranded in South America. Little other information ever came out, but it is now known that at least six Savoia-Marchetti 83's were among them—part of the fleet which maintained a service between Rome and Rio de Janeiro and which was frozen by Brazil when the nature of the airline "service" became a little too obvious. A total of 211 Southern Atlantic crossings had been completed, with 424 passengers, about 130 tons of freight, and 80 tons of mail transported to Axis countries. While this three-engine S-M plane had excellent performance (such as a 245-mph. cruising speed and a 2,500-mi. range), its wood and metal tubing fabrication was flimsy, it seemed to be hard to handle in bad weather, and further had an awkward tendency to catch fire. Both the Italian line and the Belgian Sabena had several bad accidents in which fire resulted in complete destruction of the craft.

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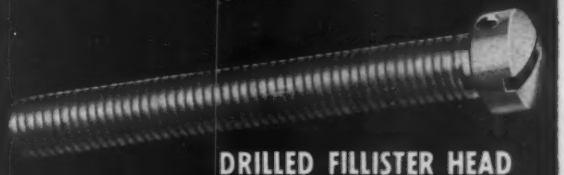

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Aviation Finance

Braniff Airways stockholders have been asked to authorize an increase in the company's common stock from 400,000 shares to 1,500,000 shares. According to Pres. T. E. Braniff, part of the new shares will be used as a stock dividend while 400,000 shares will be sold through F. Eberstadt & Co. to secure additional funds.

Lockheed Aircraft Corp. reports that production in the first half of 1943 was around $330,000,000—double the dollar output in the like 1942 period. Pres. Robert Gross announces that renegotiation of 1942 earnings was completed on June 4 with the amount agreed upon for the government exceeding the reserve of $39,927,180 by $15,572,820. A net amount of $3,099,274 was charged against 1943 profits and was partially offset by a transfer from contingency and postwar reserves.

Republic Aviation Corp. has retired 25 percent of the second preferred stock, leaving 150,000 shares outstanding. Retirement of the rest of the second preferred at $10 a share would be advisable if it can be arranged, Ralph S. Damon advised stockholders in a final message before resigning the presidency. Mr. Damon said he expected to retain his common holdings which he purchased in the open market. During his tenure with Republic, he said, both floor space and backlog of orders had increased ten times while personnel had been expanded eight times.

Grumman Aircraft Engineering Corp. has declared a dividend of $1 a common share as compared with a payment of 75c. in Aug. 1942.

Sperry Corp. also paid a 75c. dividend to stockholders in August, having declared a similar amount in July 1942.

Douglas Aircraft is delivering combat and cargo planes at the rate of $100,000,000 a month, and gross sales for the fiscal year ending in November will exceed $1,000,000,000 compared with $501,000,000 in the previous fiscal year, according to vice-pres. Ralph V. Hunt.

Solar Aircraft reports net profits of $988,824 or $3.01 a common share for the fiscal year ended Apr. 30 compared with $280,384 or 78c. a share in the preceding year. Pres. Edmund T. Price, in commenting on dividends, said that under the policy laid down by the Federal Reserve Bank an increase in dividend payments has been impossible since dividends have been limited to amounts paid before certain loans were made to finance war business. Some modification of these conditions is being sought by the company, he said. "It is anticipated," he added "that when conditions return to normal larger dividends can be paid provided that the problems of postwar rehabilitation are not excessive."

By RAYMOND L. HOADLEY

The big "but" in those dividends . . . A 10-million "drop" in a 12-billion "bucket" . . . Favorable straw in wind bears promise for airlines

A RECENT SURVEY made by the New York Stock Exchange on dividend payments in the first half of 1943 showed that the listed aviation group paid out 98.5 percent more in dividends than in the like 1942 period—a fact that was widely commented upon in the press. This, at first reading, smacks of big wartime profits for the aircraft manufacturers—but a little further study does not bear out such startling implications.

The fact is that only 3 of the 18 listed aviation concerns paid any dividends at all in the first half of 1942. Reason was that the 1942 tax bill was pending, hence the aircraft financial heads decided to wait and see where they stood on taxes before determining dividend policy. That meant that dividends usually paid in the forepart of the year were postponed last year until the fall months.

This year the situation is vastly different. New corporate tax legislation was postponed until fall and Congressional leaders gave assurances that new taxes would not be retroactive. Last spring, therefore, the aircraft industry knew where it stood on 1943 taxes and was able to go ahead and pay the dividends usually disbursed at midyear. This they did. As a result, eight aviation concerns paid $10,184,000 in dividends in the six months ended June 30 compared with the three that paid $5,131,000 in the first half of 1942.

So it all boils down to this: Some companies paid dividends in June instead of saving them up for one lumping big payment at the year-end. Total 1943 payments by the aircraft industry probably won't show much, if any, gain over 1942. Nevertheless, that 98 percent gain for the first six months is there on the record, so hostile columnists and politicians may be expected to make the most of it. And, incidentally, $10,000,000 dividend payments in any six months in an industry whose annual sales are well past the $12,000,000,000 mark is small potatoes indeed.

While writing on stock market angles, it might be mentioned that the market value of all aviation stocks, airlines and manufacturing, stood at $708,621,000 on June 30 as compared with $544,820,000 on Dec. 31, 1942. But here again an explanation is needed. The gain was all made by the airline group which sold up in new high ground. The aircraft manufacturing stocks continued to rest on their oars as they have been doing since 1938, huge backlogs and fantastic sales records to the contrary notwithstanding.

No wonder the airline stocks have enjoyed a better market than the manufacturing equities. Net earnings of 15 domestic airlines for the first quarter of 1943, according to the Brooks Earnings Indicator, were $3,458,000 compared with $603,000 in the like 1942 period. However, airline earnings may run into something of a snag later this year when they reach the excess profits brackets. On the other hand, government renegotiation officials already have asserted that profits of the aircraft makers this year would be kept under those of 1942.

Another straw in the wind that can be placed on the favorable side of the ledger for the airlines is the present attitude of members of Congress toward attempts of the railroad and steamship companies to enter air transport. A large number of applications for air routes have poured in on the CAB from railroad, bus, truck, and steamship concerns. But sentiment in the Senate's powerful Interstate Commerce Committee appears to be strongly against letting these other transport industries cut in on the air routes. In fact, it is expected that restrictive legislation will shortly be proposed in the Senate by members of this committee, who have been studying the matter for many months.

Aviation stocks sold by company heads in May, according to SEC reports, included 9,000 shares of **Aviation Corp.** by C. Coburn Darling, a director; and 7,100 shares by Victor Emanuel, president; 2,500 shares of **Chicago & Southern Air Lines** by David D. Walker, a director; 1,000 shares of **Penn-Central Airlines** by John W. Donaldson, a director; and 1,000 shares of **United Aircraft Corp.** preferred by F. B. Rentschler, chairman.

Eastern Air Lines reports net earnings for the March quarter of $757,296 or $1.31 a share compared with $619.261 or $1.07 a share in the like 1942 period.

Penn-Central Airlines and **Beech Aircraft Corp.** have been listed on the New York Stock Exchange, while **Jacobs Aircraft Engine Co.** has made its initial bow on the New York Curb Exchange. Jacobs reports net profits for the four months ended Apr. 30 of $1,519,465 or $2.45 a capital share.

Bell Aircraft deliveries of planes and ordnance equipment will be substantially greater in 1943 than in 1942 and it is anticipated that a reasonable profit will be realized, Pres. Lawrence D. Bell informed stockholders in a letter accompanying the recent dividend payment. The profit percentage will be smaller this year, he said, but the volume will be greater.

Brewster Aeronautical Corp., under an agreement affirmed in the New York Supreme Court, will allow **Brewster Export Co.** $500,000 of the $2,300,000 it claimed was due it as commission under export contracts. Brewster Export, in turn, relinquishes claim to the additional $1,800,000.

Northeast Airlines reports net profits for 1942 of $77,097. In addition there was a non-recurring profit of $105,899 arising from the sale of planes and equipment.

Boeing Aircraft has purchased the government's interest in Boeing plant No. 2, together with the administration building, for $7,769,364.

Pan American Airways transport business would have increased 300 percent over the 1942 showing if delivery could have been obtained on new equipment ordered before the war, Pres. Juan T. Trippe told stockholders at the annual meeting.

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Aviation People

H READ COOLEY has been appointed New York publicity representative for American Airlines. He has been associated with AA since 1940 as New York traffic representative and before that was manager of the Buffalo ticket office.

EARNEST A. LONG, chemist, has been named by Pres. S. G. Thornbury of Turco Products to head the material control department of the firm's laboratory in Chicago. He was formerly with the Aluminum Co. of America.

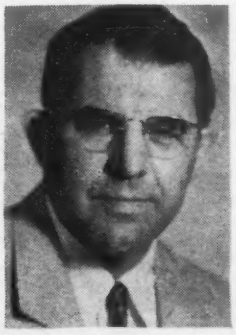
MILO McCAMMON is now assistant general production manager of the Bendix Products Div. of Bendix Aviation. Before joining the company in 1941, he was supervisor of production planning at Hudson Motor Car.

Bell Aircraft Photo

LEIGHTON W. ROGERS, former executive vice-president and later president of the Aeronautical Chamber of Commerce (1933 to 1939), has joined the Bell Aircraft Corp. as assistant to the president.

JOHN T. PROUT, in charge of plant protection for Dowty Equipment Corp., has been appointed director of personnel. Decorated by the French in World War I, he later was associated with Equitable Life Assurance Society.

WILLIAM G. KEY, until recently city editor of "The Atlanta Constitution," has joined Pennsylvania-Central Airlines as assistant to Director of Public Relations Bell. For the past two years Mr. Key was Wing Staff Officer of the Civil Air Patrol in Georgia.



HIRAM S. HALL has been appointed industrial relations director for the Ranger Aircraft Engines Div. of Fairchild. Former manager of operations at Aircraft Radio Corp., he succeeds F. Shugert, now with the Elastic Stop Nut Corp.

United Air Lines Photo

J. PRESCOTT BLOUNT is now with UAL's air cargo division. He formerly represented the Association of American Railroads. Also added by the division is William T. Henry, former statistician with the Hinsdale (Ill.) school system.

Bell Aircraft Photos

CHARLES L. BEARD has been elected a vice-president of Bell Aircraft and will hold this office in addition to that of secretary of the corporation. Succeeding him as treasurer is LOUIS FENN SPERRY (right) formerly treasurer of the Panhandle Eastern Pipeline Co. The two appointments followed Mr. Beard's recent assumption of new duties in the capacity of administrative assistant to the president. Creation of this position came at the time divisional status was given the firm's principal activities.

HAZEL BROOKS, supervisor of stewardess service for American Airlines, has received the Award of Merit, highest honor given to AA personnel, for "unusual meritorius service in teaching and exemplifying the highest standards of stewardess service."

KENNETH R. REARWIN, sales manager and assistant to the president of Commonwealth Aircraft, is now treasurer of TWA. Former Rearwin company executive, he remained on the staff when the firm changed its company name to Commonwealth.

Master Photo

J. H. (JOE) FOUNTAIN has been appointed publicity manager in Sperry Gyroscope's public information department and will perform certain assigned duties as special assistant to the vice-president for sales.

Dick Whittington Photo

FERRIS R. MILLER has been appointed vice-president in charge of industrial and public relations for Aircraft Tools. His son, Wade, is company president. Mr. Miller was formerly with Goodyear and also the State (Calif.) Corp. Dept.

Loomis Photo

PAUL M. DOLLARD, formerly secretary-treasurer of Adel Precision Products Corp., is now executive vice-president and secretary of the firm according to an announcement made by Pres. Ray Ellinwood. New treasurer is S. Amdisen.

Recent Books

SKY MASTER: THE STORY OF DONALD DOUGLAS, by Frank Cunningham. Dorrance & Co., Philadelphia. 321 *pages, illustrations, index,* $3.

When Orville Wright was informed that Donald Douglas had been chosen to deliver the 23rd Wilbur Wright Memorial Lecture in 1935, he cabled the Royal Aeronautical Society: "Development of the airliner has been an outstanding feature in American aviation. Mr. Douglas' part in this has been second to none. We are proud of him."

Douglas' father, however, modified his pride with a natural if personal criticism. After a non-stop flight from Los Angeles to New York in one of his son's earlier planes, he complained, "It was a great ride, but my back felt as if it were broken for two days afterwards."

It has been easier for Douglas to please other people than his father. And in the course of this biography, one finds that since he resigned a $500-a-year instructorship at MIT, after finishing a four-year course in two, some of the measures of his success as a designer and builder have been construction of the first Army planes to fly around the world in 1924, successively larger orders for now-famous military planes, a near monopoly in the building of American transport planes, and the winning of the Collier Trophy for 1935.

In his move to set these accomplishments against their background in aviation history, Mr. Cunningham offers comparative recitations of other men's work.

THIRTY SECONDS OVER TOKYO, by Capt. Ted W. Lawson, edited by Robert Considine. Random House, New York. 221 *pages, illustrations,* $2. *MALTA STORY, by W. L. River. E. P. Dutton & Co., New York.* 222 *pages,* $2.50. *"WILDCATS" OVER CASABLANCA, by Lts. M. T. Wordell and E. N. Seiler as told to Keith Ayling. Little Brown & Co., Boston.* 309 *pages,* $2.50.

More adventure stories follow close upon W. L. White (*Queens Die Proudly*). Capt. Lawson's story, polished by a professional writer, is a dramatic move-by-move account of his part as pilot in the Doolittle raid and his subsequent escape from China after losing a leg.

You may not hear so much about *Malta Story*, but put it down as one of the best experience yarns yet to come out of the war. The scope of action is obviously part of the reason; it covers a year of the aerial life on the island when the "Eyeties" and Nazis (stated to have methodically machine gunned parachuting pilots) gave Malta all they had (4,000 raids in 400 days) —and failed to destroy its spirit. Mr. River has dramatized in first person the diary and experiences of RAF Flying Officer Howard Coffin, an American who was one of six survivors of 200 pilots sent into Malta in the summer of 1941. What makes the story satisfying is its depth; it is no great clap on the back for heroic flying, but a tender and at times humorous blending of feelings, of courage and the emotions that make courage strong—laughter, friendship, anger, love, and continually death. Malta is a monument to democratic man's belief in individual worth, his eternal resistance to despair, and this is the story of men whose faith would not die: "The rocks of Malta continued to crumble under the iron rain and the people lived in the dark, unyielding; all might die, but the tomb itself would somehow live."

Mr. Ayling was aboard an aircraft carrier that supported the first troop landings in Africa. His book is a report of what the flyers said about the operation.

SMOKE STREAMS, by Charles T. Ludington. Coward-McCann, New York. 144 *pages, illustrations,* $2.75.

To explain aerodynamics visually, the text of this book is studded with picture studies of the behavior of various airfoils tested in the Griswold Smoke Tunnel at Old Lyme, Conn. "The work of Mr. Ludington and his associates in the last few years and his presentation of the results in pictures and text," writes Edward P. Warner in a preface, "have raised the application of smoke-streams to aeronautical education to a new level."

THE WAR PLANE AND HOW IT WORKS, by Capt. Burr W. Leyson. E. P. Dutton, New York, 224 *pages, illustrations, glossary, index,* $2.50.

In addition to a succinct, non-technical explanation of how a plane flies (elementary aerodynamics, engines, superchargers, instruments), Capt. Leyson includes six chapters on what it fights with—including machine guns, cannon, and power turrets. The approach is simple and briefly historical, concluding with a suggestion of the pressure upon the flyers: "Although it appears that from both the aerodynamical and mechanical point of view airplanes capable of sonic speeds can be built, they will prove impractical due to physiological limitations."

FLIGHT FOOD, by T. Kent Morris. Ben Jaffe, Los Angeles. 32 *pages, paper bound,* 50c.

Notes on eating for passengers and crews, affect of altitude on the body, preparation of diets, and the service of meals aloft. The author is the catering manager of Pan American Airways.

WAR PLANES OF ALL NATIONS, by William Winter. Thomas Y. Crowell Co., New York. 418 *pages, illustrations, index,* $3.

Canvassing types of planes, developed, discarded, and still doing business in this war, Mr. Winter arrives at a count of 274—U. S. 59, Great Britain, 32, Russia 30, France 35, Holland 10, Germany 43, Italy 35, and Japan 30. Pictures, drawings, and discussions of their specifications, particular features, and comparative performances are naturally restricted by reasons of security and availability of information. But within the limits Mr. Winter makes interesting assessments.

AIRCRAFT POWER PLANTS, by Arthur P. Fraas. McGraw-Hill Book Co., New York. 472 *pages, illustrations, index,* $4.50.

With commendable directness and simplicity, Mr. Fraas, an instructor in New York University's Guggenheim School of Aeronautics, presents the essential facts about airplane engines. The discussion is divided into two sections, operation and installation, which include descriptions and graphical and mathematical illustrations of combustion, supercharging, carburetion, ignition, cooling, fuels and lubricants, as well as engine mounts, cowling, and liquid-coolant, induction, exhaust, fuel, and oil systems. There are also a short section on propellers and an appendix of laboratory instructions plus tables and curves on installation design and testing.

ENGINEERING INDEX: 58th EDITION. Engineering Index, Inc., New York. $50.

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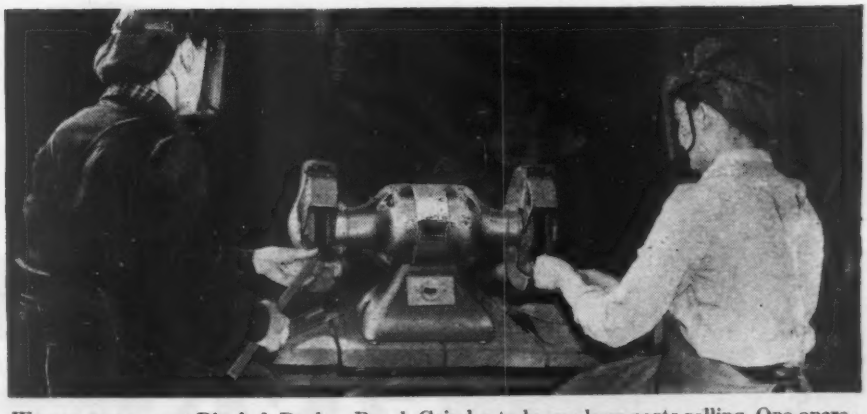

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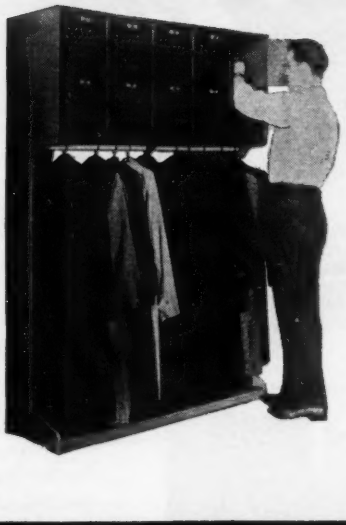

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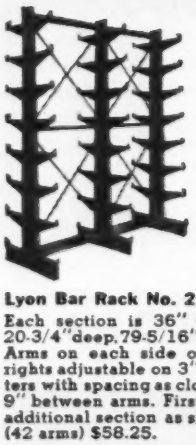

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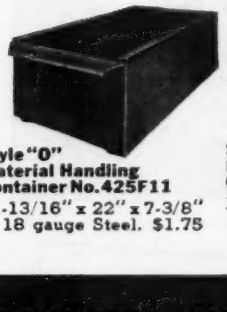

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Conservation in Canada's Aircraft Industry

(*Continued from page* 181)

ing machine and a lathe are freed and an annual saving of $75,000 has been chalked up.

Plywood has been widely used on the Canadian-built Avro *Anson*, twin-engine bomber trainer built by Federal Aircraft, Ltd., a government-owned and operated company. Parachute stowage compartments, four on each *Anson*, were formerly made of aluminum sheet and used rubber shock cord. They were processed with punch press and by hand. Now plywood, webbing, and springs make up the compartment, which becomes a cabinet maker's product, calling for woodworking machinery instead of the punch press. The four compartments are now fabricated with an annual saving of about 15,000 lb. of original materials, about 87,000 hr. of labor, and about $130,000 in labor and materials.

Biggest saving from the switch to plywood is in reduction of man-hours. More than 2,000,000 hr. are saved by production speed-up on the *Anson* fuselage, accounting for a considerable part of the $1,280,000 saving on the fuselage cost.

Plywood has been used with equal savings on the *Anson* to make the code book stowage compartment, the bomb door, a compartment for calculating equipment, seats, tank cover, 22 inspection doors, detachable gun panel, inspection panels, pilot's map case, aileron chain guard, and aerial mast, the last now being made of laminated wood instead of streamlined steel tube and welded plate. The items formerly involved use of aluminum sheet punch-pressed and hand-formed. The savings of 2,750,000 man-hours plus material costs reduction runs close to $3,500,000 annually.

Pilot's seat cushions and prone bomber's cushion used to be leather covered and rubber filled. The shortage of rubber required a substitute, and meanwhile the leather was changed to Fabrikoid. Now crew members sit and bombardiers lie on curled hair filled cushions.

Metal parts have also come in for redesigned new construction, of which the following instances are samples: The shackle for the elevator lever on the *Anson*, once made of machined bar stock, now is comprised of steel plate and round bar, saving 5,100 lb. of material and 2,000 hr. of labor a year. The locking handle on this aircraft, formerly made of machined and welded bar stock, now consists of welded scrap tubing and bar stock, eliminating two machine tools and saving 1,250 lb. of material and 1,850 hr. of labor a year. Eyebolts which were formerly machined from round bar stock are now screwed and welded from the same stock, saving 7,000 lb. of material and 2,500 hr. of labor. Sprockets are now made with a smaller bar stock and contain five less rivets. And a hand control which was formerly machined bar stock is now made of cast aluminum and has a machined hub, saving 2,750 lb. of material and 2,200 hr. of work.

Standardized parts have been substituted wherever possible for specially designed parts. Thus cabin lighting in the *Bolingbroke*, which initially was of special welded aluminum construction, has been replaced by purchase of standard parts. Hydraulic control valves on this aircraft formerly were made of duralumin bar and forgings, steel tubing, bronze bar, sheet steel, and steel chain. Now a standard aircraft part which can be purchased outside the factory is used, thus conserving thousands of pounds of specially constructed metal material, eliminating milling machines, turret lathe, engine lathes, and screw machines, and saving upwards of $25,000 a year in labor and material.

Simplification of construction has also resulted from the conservation measures. The radio rack on the *Bolingbroke* bomber used to call for assembly of 26 pieces of tubing and plate. Now, by using the same type tubing and adding sectional bends of welded construction, the assembly has been brought down to 8 pieces. And where formerly the radio rack was sand-blasted, cadmium plated, and painted, it is now given a heavy enamel finish. The redesign not only saves $61,000 in labor and material but also frees welding equipment, drill jigs, and sheet metal equipment.

Compression springs which formerly had the ends ground square now have the ends closed but not ground, saving the work of a grinder and 1,000 hr. of labor a year on one type of aircraft. Sheet metal spinnings, formerly hand formed, are now processed by metal spinning. A window operating mechanism has been redesigned to save, on one specific plane, 1,200 lb. of metal a year and 16,250 hr. of labor, while freeing six machine tools.

A mahogany radio operator's table has been replaced by one made of wallboard, and plywood navigator's and wireless operator's tables have been redesigned to allow improved methods of plywood construction to save thousands of hours of labor.

These are just a sampling of the measures which have been taken by the Canadian aircraft industry to conserve materials, time, and labor, and there is a constant search for more methods of saving raw materials, skilled and un-

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skilled labor, machine tools, and time.

Canada's wartime aviation industry, under the leadership of Director General of Aircraft Production Ralph P. Bell, has stressed conservation from the very beginning. The program is now part of a Dominion-wide industrial conservation campaign covering all branches of Canadian war industry.

Spinner and Cowl Inlet Combinations

(*Continued from page* 159)

gradient will be built up tending to increase the thickness of the boundary layer and to produce separation, which will most likely initiate on the top surface of the spinner. Apparently the loss in pressure head due to separation is of the same order as the one due the hub in installations without spinner, which may account for the fact that in many cases no difference in pressure recovery was observed in identical installations, one with spinner and one without.

Even if separation does not occur by the time the boundary layer passes the propeller plane of rotation, it will be in a close to critical condition. Little energy is added to it by the propeller, as mentioned above. An additional positive pressure gradient is now superimposed on the already existing pressure field because of the required diffusion into the cowl inlet. Obviously, for each spinner and for each performance condition there will be a critical inlet velocity ratio for which separation will occur ahead of some critical point, the decrease of the velocity ratio having the same effect on the spinner and its continuation—the afterbody, as an increase of angle of attack on an airfoil.

In climb the spinner will have an angle of attack of its own, which will be zero for its horizontal and a maximum for its vertical section. Thus, in the vicinity of this vertical airfoil section, the positive pressure gradient will reach its maximum value. Fortunately the inlet velocity ratio tends to be high in climb for most designs, and this at least does not make matters worse.

This critical boundary layer condition strongly suggests some sort of boundary layer control, which can be obtained by utilizing the static pressure pool existing in front of the cylinders and supplying its energy to the boundary layer through the required clearance gap existing between the spinner and the afterbody. This will be more effective the closer the gap is to the propeller.

It appears, then, that from the standpoint of the spinner, the velocity ratio should be as high as possible to delay separation at least for moderate angles of attack. On the other hand, the losses

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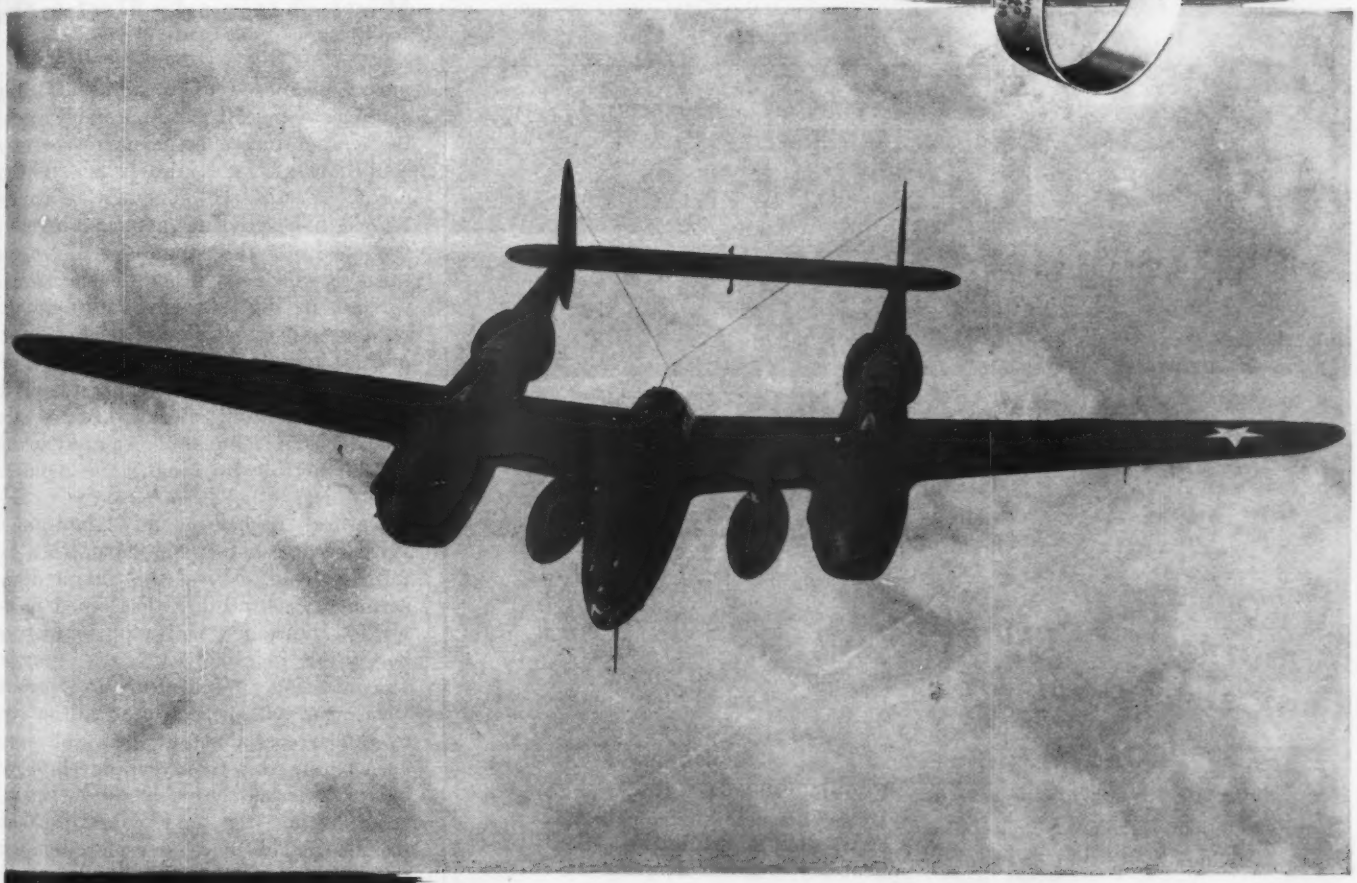

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occurring from the entrance section to the face of the engine will be smaller, the smaller the entrance velocity, considering the losses as a function of the local dynamic pressure.

Analysis of the problem would thus boil down to the following steps:

1. Determine the pressure distribution of the spinner for different angles of attack, corresponding to different flight conditions.

2. Assuming that the pressure distribution of the spinner up to the propeller plane of rotation is unaffected by the inlet velocity ratio, modify the pressure distribution past the propeller using a linear pressure gradient established by different inlet velocity ratios, and by the internal diffuser ratio.

3. Determine the separation point by any one of the methods used to find the separation point for airfoils, selecting the vertical spinner section as the "design section."

4. Choose such a velocity ratio and such a spinner afterbody combination that the separation will be brought past the gap.

In so establishing the optimum inlet velocity ratio, due consideration must be given to the losses in the diffuser section between cowl entrance and engine.

The above analysis would be greatly simplified by the standardization of spinner forms similar to NACA airfoils. And as an afterthought, it may be added that for some spinners, the critical Mach number may be as low as 0.4 for comparatively small angles of attack. This will be particularly true for the spinners of large thickness ratio. Thus the thickness ratio and its corresponding critical speed should form a definite limiting factor in the selection of spinners.

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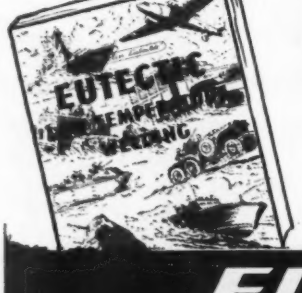

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New Guides to High Altitude Rubbers

(*Continued from page* 154)

must be exposed for a sufficient length of time to permit this. Merely raising the temperature is sufficient to correct a condition of this kind when it does occur. A stock will generally re-acquire its original properties after having been frozen—and the number of cycles through which a synthetic rubber is put will not in any way affect its ability to regain its original characteristics. However, if the material is subject to pressure or flexing of some kind during its frozen condition, a fracture or flex crack may develop that certainly would not be curable by raising the temperature.

Natural rubber in an unvulcanized state becomes stiff and hard when exposed to cold. It was this characteristic as much as any other that stood in the way of the commercial adoption of rubber prior to Goodyear's discovery of vulcanization. MacIntosh in England was somewhat successful with the type of rubber coat that now bears his name even before this Goodyear development, but in America the rubber industry was encountering the first cold resistance problem. The more extreme climate in this country caused rubber coats to "serve well both as a suit of armor and a protector from the weather," in the words of one commentator of the time. With vulcanization, the freezing point of rubber was lowered considerably. And natural vulcanized rubbers are compounded very successfully in temperatures of —40 deg.

For the first few years following their introduction, the synthetic rubbers were no match for the natural rubber as far as freeze resistance was concerned. That situation has now ben reversed due to improvements in the synthetics in this regard, and there is indication of even greater superiority in the future. The synthetics will most certainly be developed to withstand temperatures below —100 deg. And that day is not far off!

The attempt of the SAE to develop standard specifications is undoubtedly a step in the right direction. The Aeronautical Material Specifications, as they

apply to rubber generally and as they apply to cold resistance in particular, comprise many requirements which we consider far too high. What is more encouraging is the outlining of a method for testing to determine whether or not rubber compounds meet the required qualifications.

AMS 3204 calls for a stock of 30 durometer, a tensile strength of 800 lb. per sq. in. and an elongation of 350 percent. After oil aging at 75-85 deg. for 70 hr. and oven aging for 70 hr. at 212 deg., it may show only limited deterioration in addition to which the stock must be capable of being flexed according to the SAE-ASTM bent loop method after being in dry air at −70 deg. for 5 hr.

AMS 3205 calls for somewhat the same requirements as 3204, except that the starting durometer is 50. AMS 3203 applies to the polysulfide (Thiokol) type of synthetic.

Each of the above requirements in every specification can be met very easily by rubber companies. As a group, however, these requirements are almost impossible to attain in one compound; nobody (to the writers' knowledge) has yet been able to meet them. But with some modifications, they should serve as a good basis for standardization. In order to obtain the optimum low temperature called for, at least part of the other requirements must be ignored.

AMS 3201 and 3202 are essentially heat-resistant stocks but also require satisfactory performance after exposure to −40 deg. for 5 hr. No company (to our knowledge) has met this specification. The cold requirement is not very difficult in itself, and the heat requirement is being met by some companies. But together they may be considered impossible, for the present anyhow.

Measurement

A great deal of confusion is added to the cold problem of rubber and its substitutes in that there is no standard method of determining freeze resistance, nor is there any universally accepted measurement for expressing this quality if it could be determined.

The measurement most commonly used for rubber is that of the Shore Durometer (Fig. 3). This instrument affords the standard method for determining the hardness of rubber under ordinary conditions. The colder the rubber becomes, the harder it gets. Hence, a rubber that may be 30 durometer at room temperature may perhaps show 80 durometer at −40 deg. However, this means of measurement is not exact. The length of time a rubber compound is exposed to a low temperature must be considered. It is conceivable that the above cited example may show a durometer of 65 when there is exposure to a temperature of −40 deg. for an hour

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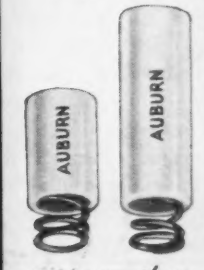

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No. 1099 — 1"

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MAIN OFFICE and FACTORY, AUBURN, N. Y.

—but perhaps the durometer reading will be 90 or even 98 when there is exposure to that temperature for twelve hours. Too often the length of time of exposure is not considered. This is very important.

Rubber exposed to extreme cold becomes stiff and is generally considered to be completely frozen when it shows a durometer reading of 100. However, because of the slowness with which a stock deflects as it gets hard, the action of the durometer is not exactly the same as when it is used at room temperature. When first brought into contact with a frozen piece of rubber, an initial deflection of the durometer needle occurs, but then it very slowly moves to its correct position. This is because the extreme cold has caused the rubber to lose a great deal of its natural elasticity and displaceability. The modulus increases with the extreme cold. It cannot be denied that the cold temperature in which the rubber is tested must also impair the accuracy of the durometer. We do not know to what extent.

The F-50 (F) measure as used by duPont is somewhat of a qualitative indication of the freeze resistance of a vulcanizate. (See Table I). It is actually a temperature measurement, and it may be difficult for an engineer accustomed to durometer or Brinnell methods to grow used to it. Indicated is the temperature at which a specimen increases in hardness midway between its Shore hardness at room temperature and a Shore hardness of 100. The value of 100 is considered to be that of maximum hardness or complete freezing. It is different from most other measurements of cold rubber in that it takes into account original durometer readings.

The so-called arc test (Fig. 4) is growing in popularity. It consists merely in bending a piece of rubber $\frac{1}{8}$ in. thick by 1 in. wide and approximately 8 in. long around a steel rod. Fingers are kept at least an inch from the rod so that no heat is transmitted at this bending point. An attempt is made to determine two points: The temperature at which the stock loses its elasticity and becomes stiff and the temperature at which it becomes suf-

TABLE I—TYPICAL EXAMPLES OF F-50 (°F.) MEASUREMENT

Temperatures	Shore Durometer Hardness of Five Compounds				
	1	2	3	4	5
82 deg. F.....	42	45	44	44	41
20 "	42	46	45	44	42
0 "	43	47	47	45	45
—10 "	44	48	48	46	47
—20 "	46	50	51	48	52
—30 "	48	53	54	51	57
—40 "	51	59	62	75	76
—50 "	56	72	81	88	93
—60 "	68	94	93	91	94
—70 "	73	94	94	92	95
—80 "	85	94	94	92	95
F-50 (deg. F).....	—66	—50	—45	—39	—37

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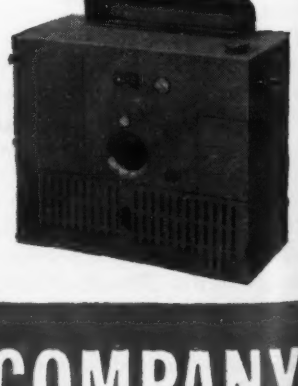

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Hunter Universal Gasoline Heaters are serving the armed forces in many ways which cannot be described, but it is an uncensored fact that they can be successfully used for heating and ventilating trailers, busses, trucks, mobile photo laboratories, field hospitals, truck or trailer-mounted field repair shops, shelters for radar and radio equipment. Also for heating and ventilating tents, portable houses, field or permanent barracks for officers, and similar housing. Certain models can be used for standby heating of truck or plane engines to assure starting in severe weather, and for cabin heating in busses and aircraft.

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Full information, or a consultation with a representative, may be had by writing or wiring Hunter and Company, 1550 East 17th Street, Cleveland 14, Ohio.

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ficiently brittle to break or crack. Judgment of the exact point at which a stock becomes stiff leaves a great deal of room for variation of opinion. Two or more people testing the same stock may very easily disagree regarding the precise point at which it loses its softness. However, as a means for testing more than one stock at the same time and under the same conditions it is a satisfactory indication of relative performance.

Temperature of rubber for testing purposes is generally reduced by dry ice (employing an ice box of some kind). *Since air does not transfer heat with any degree of rapidity, a great deal of time must be allowed to permit the material to reach the desired temperature.* The so-called T-50 tester (Fig. 5) as developed by United States Rubber Co. and manufactured by the Henry L. Scott Co., uses a liquid as a coolant. Both methanol and acetone are satisfactory. Because of the greater speed with which temperatures can be transmitted, the T-50 method permits rapid and more accurate determination of freeze resistance in rubber. Actually, a durometer is used as a measure of hardness when the rubber is reduced to the desired temperature for testing.

But the durometer, as pointed out, is not entirely satisfactory under certain conditions. Indeed, none of the methods generally used for measuring the freeze resistance of rubber compounds can be considered thoroughly satisfactory. Hardly a month goes by without the introduction of some new way of testing the cold qualities of rubber. Work is now going on to develop a method of studying and representing modulus at lower temperatures down to the point where a stock has zero elongation. Where elongation ceases, we have what may be considered a freeze point. It must be borne in mind that a compound can be bent at a point below a designated freeze point arrived at by this method, and another measurement will have to be utilized to determine the final point at which a flex crack from some standard bend will occur. This would actually be a dual measurement, and we might say that a particular synthetic has a freeze point of 60 deg. (where elongation is zero) and a flex point of 85 deg. (the point at which a flex crack occurs after checking by some standard test method).

The standard test of freeze resistant qualities on rubber recommended by the SAE-ASTM technical committee and developed by the Thiokol Corp. is probably the best of the tests currently used (Fig. 6). Slab strips are placed in a machine where they are bent. By controlling the manner in which the ends of the strips are attached, the piece being tested can be bent into any desired radius. The sample is flexed by

TABLE II—
COMPARISONS OF COLD RESISTANT PROPERTIES OF RUBBER AND NEOPRENE

Hardness After	At	FR Neoprene	Rubber
0 min.	82° F	40	47
15 "	20° F	40	48
15 "	0° F	40	49
15 "	−10° F	40	49
15 "	−20° F	41	50
15 "	−30° F	42	52
20 "	−40° F	44	56
25 "	−50° F	48	70
30 "	−60° F	52	90
35 "	−70° F	67	92
60 "	−80° F	91	94
F-50 (°F)		−72	−52

means of a crank and is not touched by the hand. Universal use of a machine of this type with a standardized arrangement as regards bend radius, size of test samples, and number of flexes, offers a definite means of comparing the freeze resistance of various rubber compounds.

Neoprene

There are many types of Neoprene. The so-called FR (freeze resistant) type is the one used almost exclusively for cold flow. Its properties in this regard are excellent, and it has been used successfully in temperatures as low as −100 deg. F. In freeze resistance, there can be little doubt of its superiority over natural rubber. (See Table II).

Where the need for dual qualities, arises, FR Neoprene is blended with other types, with a sacrifice of freeze resistance occurring in proportion to the blend. If a low-swelling stock as well as one resistant to cold is required, then Ils (swell resistant) is mixed with FR. The result obtained depends on how much of each blend is used.

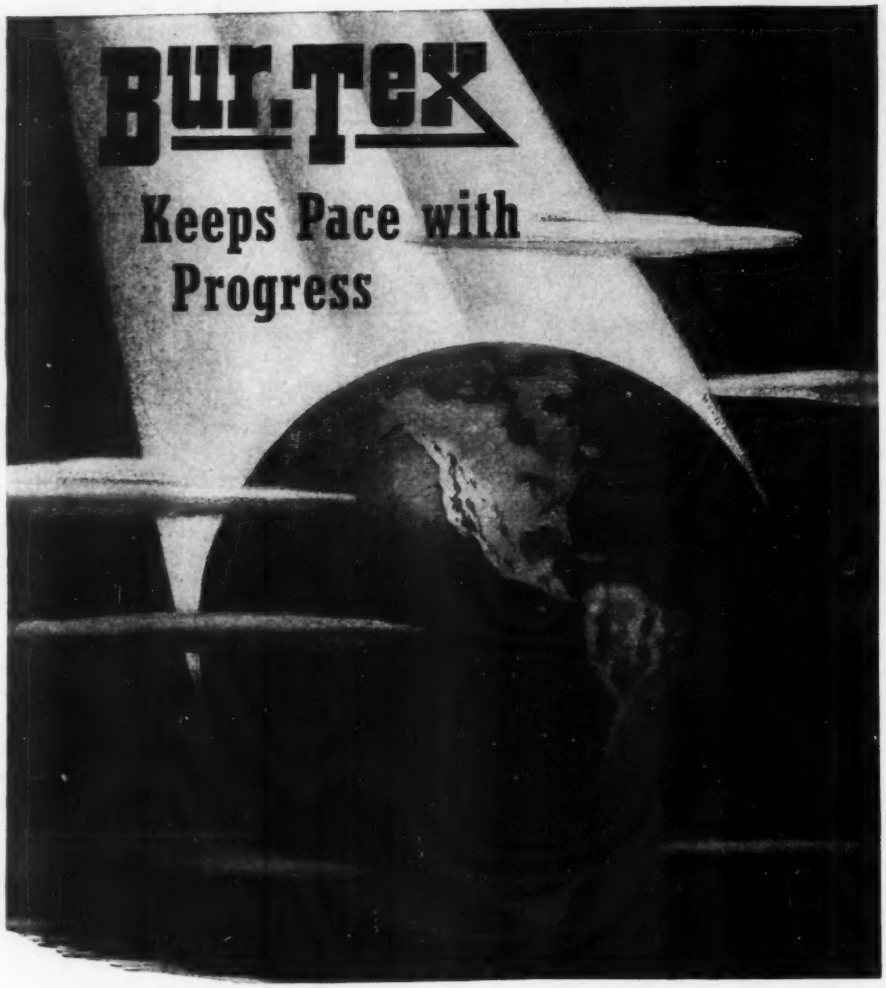
Compared with other types of Neoprene, FR has the following characteristics:

1. Much lower compression set.
2. Greater resiliency.
3. Lower swell in water.
4. Equal flame resistance
5. Equal resistance to heat, sunlight, and aging.
6. Slightly lower tensile strength and elongation at break
7. Slightly greater swell in petroleum products.

Because of its greater swell in petroleum hydrocarbons, the use of Neoprene FR has not been satisfactory for hydraulic "O" rings (AN 6227 and similar parts) despite its excellent freeze resistance qualities.

Buna Type Synthetics

As long as no plasticizer is used, the buna S syntheties have a superior resistance to freeze resistance than buna N. However, the addition of plasticizers changes this completely since, by their use, buna N can be made to have greater resistance to cold than buna S. In ad-



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dition to this, it must be born in mind that buna S has no oil resistance.

Buna N types are considered to be those that are copolymers of butadiene and acrolonitrile. Buna S uses styrene rather than acrolonitrile. The actual amount of acrylonitrile present in buna N in relation to the butadiene will vary in the commercial products of various companies. However, it is definitely certain that the lower the nitrile content, the greater the freeze resistance of the resulting synthetic—and also the lower its resistance to oils. On the other hand, as the nitrile content is increased, we increase oil resistance and decrease freeze resistance.

In considering the effect of acrolonitrile, certain other factors must also be considered. The modifying agents in the raw material may have just as much influence on the finished product as the compounding. This is particularly true of the plasticizer. While butadiene-acrolonitrile copolymers having very low nitrile content have low temperature freeze resistance, there is an extremely narrow margin between the minimum flexibility point and the temperature where actual brittleness will set in. *This must be kept in mind.*

Perbunan, with the lowest nitrile content of all buna N types available, has two outstanding properties that are often called into use: Resistance to solvent swelling and low temperature flexibility. But there is a catch in that only *one* of these properties may be developed in a compound at a particular time. Each may be improved, but strictly at the expense of the other. As with other types of synthetics, control over the freeze resistance of Perbunan is maintained by the type of compounding ingredients (known generally as softeners) which are used.

So far, no freeze resistant softener has been discovered which can be truly considered insoluble in oils. While a stock may be imparted excellent cold qualities, the minute it becomes necessary to use it in a petroleum hydrocarbon, it becomes merely a matter of time until the softener which supplied the freeze resistance is removed and the material becomes stiff and leathery. With one possible exception, aromatic gasolines will extract softeners with great speed.

As compared with FR Neoprene, Perbunan is not quite so cold resistant, but it has less swell in fluids and a slightly higher tensile factor. These other qualities are often necessary in cold resistant rubber applications, so actually more FR Neoprene is used for cold purposes.

Hycar has less swell than either FR Neoprene or Perbunan, but it cannot stand as low temperatures. Hycar is one of the butadiene types of synthetic. The type generally in use, and until re-

TABLE III—
TYPICAL EXAMPLES OF REACTIONS OF HYCAR TO COLD

Shore durometer hardness, original	90	70	60	50	80
Shore durometer hardness after one week at 0°F	95	73	64	52	85
Shore durometer hardness after one week at −50° F	97	90	90	82	93
Bend tests (180° around ⅜ in. rod)	No checks, cracks, or breaks in any instance.				

cently known as Hycar OR (now OR-15), becomes stiff at about −50 deg. F. It can be bent through a 180 deg. arc around a ⅜ in. rod at that temperature without shattering, checking, or cracking. Should it become stiff, it recovers its pliability immediately when a rise in temperature occurs. The results obtained after one week at −50 deg. F. are included in the accompanying Table III.

Hycar OR-25, recently announced, is a material for low temperature service. It remains flexible, can pass the 180 deg. arc test at −76 deg., and does not become sufficiently brittle to crack until it gets down to −104 deg. and then is bent over the arc. Tensile strengths as high as 2,350 lb. per sq. in. can be maintained, and the stock has a room temperature durometer of 52. This type of Hycar has a greater swell in oil and gasoline than Hycar OR-15 and its tensiles are also lower as well as elongation. This information also applies to Ameripol.

Hycar compounds are in the class of materials that do not have the very lowest freeze points but provide a great deal of leeway between the temperatures where hardness sets in and brittleness occurs. For general use both as a freeze resistance material and in oil or aromatic gasoline, Hycar is head and shoulders above competing materials. Hycar compounds may get hard at −65 deg. but do not actually become brittle till −100 deg. In addition, Hycar does not suffer from the decrease in tensile and other properties that sometimes accompany high nitrile content butadiene-acrolonitrile polymers.

Thiokol

Thiokol can be compounded so as to remain reasonably flexible at 60 deg. Type FA must be used. Considerable investigation has been made of the low temperature action of government Thiokol (GR-P). Stocks of this type become stiff at about 0 deg. and brittle at about −20 deg. As shown below, however, a longer time is necessary for brittleness or stiffness to set in under cold conditions than is the case with other synthetics:

GR-P	Time to become brittle
− 5 deg.	24 hr.
−20 deg.	20 hr.
−30 deg.	5 hr.

Where Thiokol of government make must be used, it has been found that by

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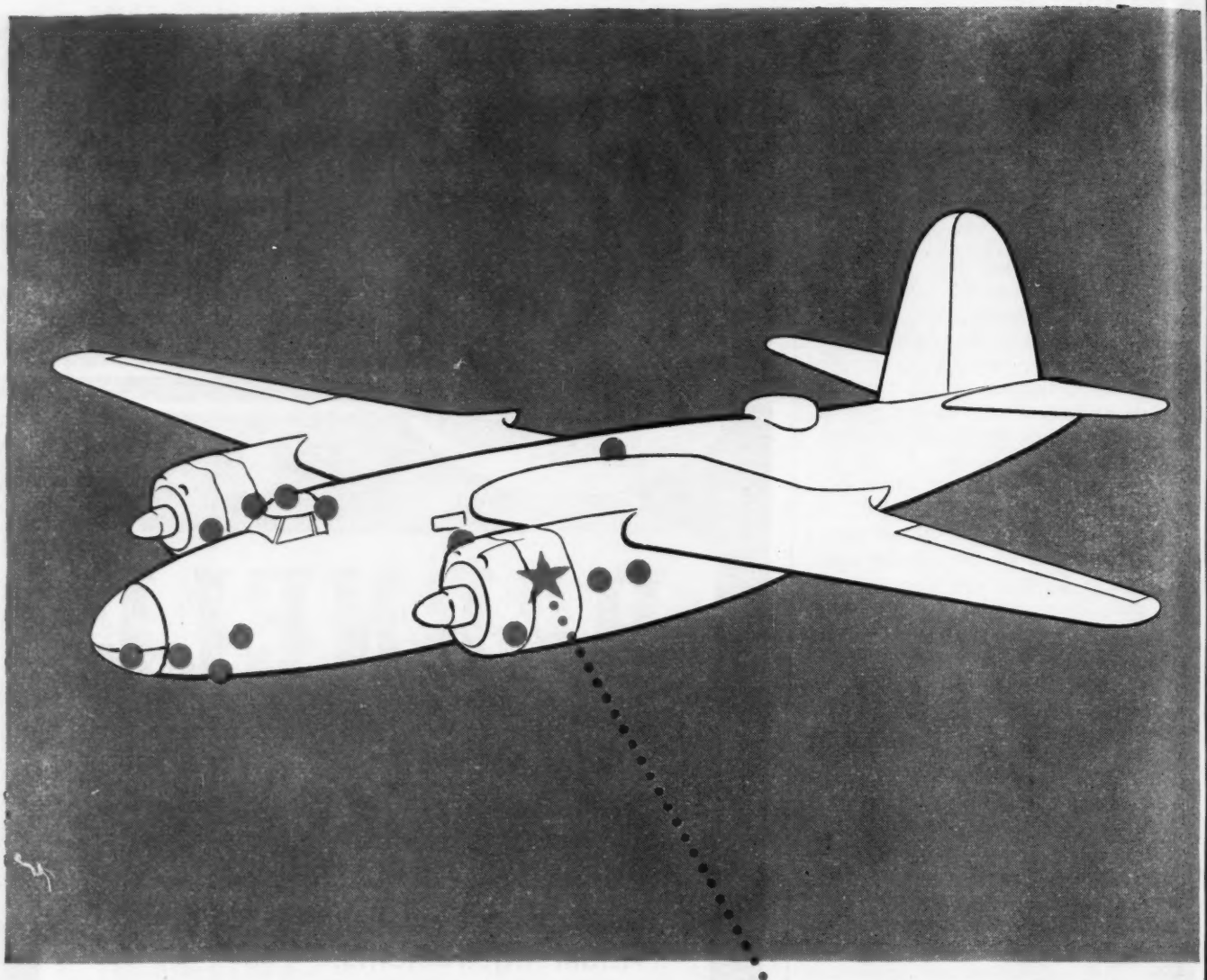

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mixing it with reclaim, better freeze resistance may be obtained.

Plasticized polyvinyl chlorides can be compounded so that they will flex at −40 deg. F. One grade may be compounded so that it will bend at −65 deg. without cracking. As a rule, low temperature flexibility is obtained at the sacrifice of tensile strength.

As with other synthetics, the exact result is determined by the compounding ingredients. The greatest value of vinyl chlorides lies in their electrical properties. The electrical loss factor is not consistent and will be varied not only according to the compound *but according to the temperature.* Generally speaking, the electrical loss factor diminishes with a fall in temperature, but it will vary considerably from a straight line.

The exact amount of freeze resistance possessed by butyl is still undetermined. Generally speaking, its action resembles that of other rubber-like materials.

To summarize, it may be said that although a general state of confusion exists both as to materials and methods of testing, lead by the AMS specifications and the Thiokol flex test as adopted by ASTM, a start has been made in the proper direction and it is not improbable that within a period of several years, rigid and understandable methods of testing and rating compounds of rubber and rubber substitutes will evolve.

It is not improbable that one or more of the various synthetic varieties now being manufactured will ultimately be eliminated. And with return of the rigors of peacetime competition, plus consideration of the new status of natural rubber which will again eventually become available, we will tend toward a specialization with particular types of synthetics—that is, a development of special-purposes synthetics whose ability to fill the particular capacities will be easily determinable by the standard tests.

Reconversion Reserves

(*Continued from page* 179)

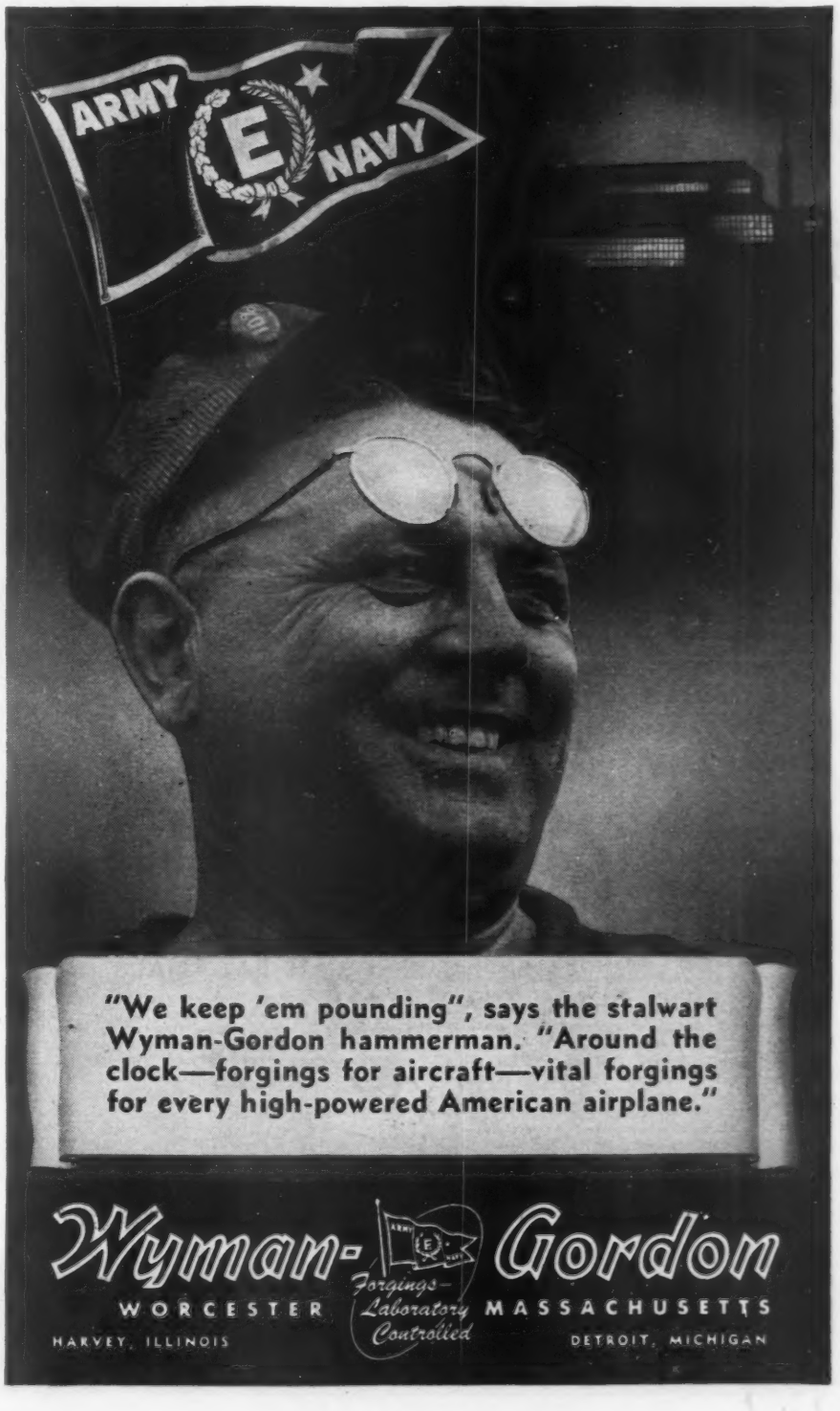
in under the law. And as Congress seldom goes against the wishes of the service departments, the aircraft industry may be fighting a losing battle in attempting to gain any substantial change in the renegotiation law at this late date.

Renegotiation officials realize that reconversion reserves are imperative for the aircraft industry. Kenneth H. Rockey, chairman of the Navy Price Adjustment Board, acknowledges that the vast majority of aircraft companies are going to be in a "very, very serious and vulnerable position at the conclusion of the war." Maurice Karker, head of the similar War Department board, has said that his board can do nothing for companies which are asking for postwar reserve provisions during renegotiation. It is up to Congress, he feels, to give tax status to such reserves.

There doesn't appear to be any deep seated opposition in the two services or among Congressmen who have studied the matter, to more liberal reserve treatment for the aircraft industry. They contend, quite logically, that companies like the textile and construction industries have few conversion problems while others like the automobile and radio industries will step into "hungry markets." On the other hand they admit that the aircraft and machine tool industries will find their present markets glutted.

Therefore the smart move would be for the aircraft, machine tool, and any other industries in the same boat, to unite on a program and present it to Congress. Its one thing to cry wolf but quite another to get together on measures to remedy the situation.

Even the government research agencies haven't a clear picture of the reserve problem or its answers. Some of them feel that since the need seems to vary from industry to industry, spe-



cific tax steps should await a time when industries can work out their own suggestions with more definiteness.

One suggestion worthy of serious consideration might be to follow Canada on this reserve problem. We have not hesitated to pattern price control after Canadian experience when we saw our northern neighbor had an anti-inflation scheme that apparently was working.

The Canadians have severe tax laws in their determination to meet, from taxes, at least 50 percent of their war budget. Yet they allow a 20 percent postwar tax credit for industrial corporations—twice the amount allowed in the United States.

Here is how Congress reasoned on the present post-war tax credit, as one authority explains it: "We think that a 90 percent excess profits tax requiring immediate payment, complete and final, into the treasury is too high. So we will let you pay your 90 percent into the Treasury and then we will save 10 percent of that for you until after the war so that you will have some sort of an asset to meet part, at least, of your postwar problems."

So why not unite on a plan to have Congress double this credit after having shown how inadequate it is for the aircraft industry, and possibly a few others in the same position, regarding reserves. It might not be difficult to get Congress to be as generous as Canada has been. It might even be possible to have the doubled postwar profit exempted from renegotiation. No one, after sober thought and a glance at aircraft balance sheets, wants such a vital war-winning industry counted out when the shooting is over.

Meantime, here is some practical advice which the financial men of every company should keep in mind in working toward postwar financial stability:

Keep your finances as liquid as possible—particularly your reserves.

Plan your operations so you won't be caught with excessive inventories in a critical period when raw material prices are tobogganing.

Develop a capital expenditure budget and an operating budget for the reconversion period—which may come sooner than you think.

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Design Approval for Long Range Aircraft

(*Continued from page* 143)

The formula for the wing structural weight thus becomes:

$$Ww = {}_{k1} \cdot \ S + k_2 \cdot W \cdot S^{1/2} \cdot \lambda^{3/2}$$

Converting into current unities the French empirical formula corresponding to this, we have:

$$W_w = 2S + \frac{6}{100{,}000} \cdot W \cdot S^{1/2} \cdot \lambda^{3/2}$$

In estimating the tail weight, we will figure that the total tail area generally approximates 25 percent of the wing surface. If we designate by t the average unit weight of the tail surfaces, the total weight can then be expressed thus in terms of the wing area:

$$0.25ts$$

For the power plant estimate, we will again divide the weight into two components: One, pertaining to the engines and their accessories, generally expressed in terms of a unit weight per bhp., which we will call u; the other, pertaining to the installation around the engine, such as nacelle, cowling, engine mount, propeller, and controls, which we will call P. Since this weight P does not vary appreciably with engines of a same class, but only with their number, n, the total weight of the power plant installation can be expressed as follows:

$$u \cdot \text{BHP} + a \cdot P$$

Thus the empirical formula which we shall consider in this study for the structural weight depending on the wing design and engine arrangement, will be as follows:

(5) $W_s = 2S + \frac{6}{100{,}000} \cdot W \cdot S^{1/2} \cdot \lambda^{3/2} + \cdot 25t \cdot s + u \cdot \text{BHP} + nP$

Although the optimum solution has thus been found, there is another equation worth mentioning here because of its importance in fixing the limits within which the engine will most likely be used and thus determining the most desirable adjustment of the carburetor and the supercharger as well as of the propeller. It is simply the fundamental equation of power required applied to the average airspeed, thus:

$$r \cdot \eta \cdot \text{BHP} = \frac{\rho}{\rho_0} \cdot \frac{.00256 \cdot C_{De} \cdot S \cdot V_e^3}{375}$$

or, since

$$C_{De} = 2C_{fe}$$

(6) $$r \cdot \eta \cdot \text{BHP} = \frac{.136}{10{,}000} \cdot \frac{\rho}{\rho_0} \cdot C_{fe} \cdot S \cdot V_e^3$$

r being the ratio of the total power required.

Since the most suitable altitude to consider for flight will be given by the operation requirements equation (3) will show the variation of the optimum airspeed for such altitude versus the plane's gross weight, and equation (6) will give the corresponding variation of the ratio of rated power which will normally be used.

Next month the author will work out a numerical example of this method, with the assistance of derived utilization curves.

Continuous Overhaul On PAA "Clippers"

(*Continued from page* 212)

flight engineer indicates on the fourth page of his log book conditions of operation and function which require immediate or special attention. This sheet is given over to the chief mechanic when the plane arrives for base check, and space is provided on the same sheet for the mechanic to write in what he has done to correct the troubles indicated. This gives the flight engineer a record of what was requested and the assurance that it received proper attention before departure.

All parts removed from an aircraft are accompanied by a red tag, on which is stated the defect requiring its removal. If the exact cause is not known, the symptoms of malfunction are indicated to furnish a guide to the repair shop indicating what to look for. Periodic checks on these red tags show, by the identifying numbers, whether the occurrence is occasional, or whether it adds up to a widespread and major condition of failure.

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Lancaster, Pennsylvania

the mechanic writes on this tag the number of the plane, airplane hours at time of installation, and location on the craft such as engine No. 1, 2, 3, or 4, left wing, etc.

Since instruments must be removed and repaired on a time limit basis, the green installation tags furnish the information enabling recording clerks to make up individual parts-record sheets like that illustrated in Fig. 2. These are compiled in a bound volume in the following classifications: Hull, hull electrical, cabin equipment, wing structure, wing electrical, engine, systems (fuel, electric, control, de-icing), instruments, and automatic pilot system.

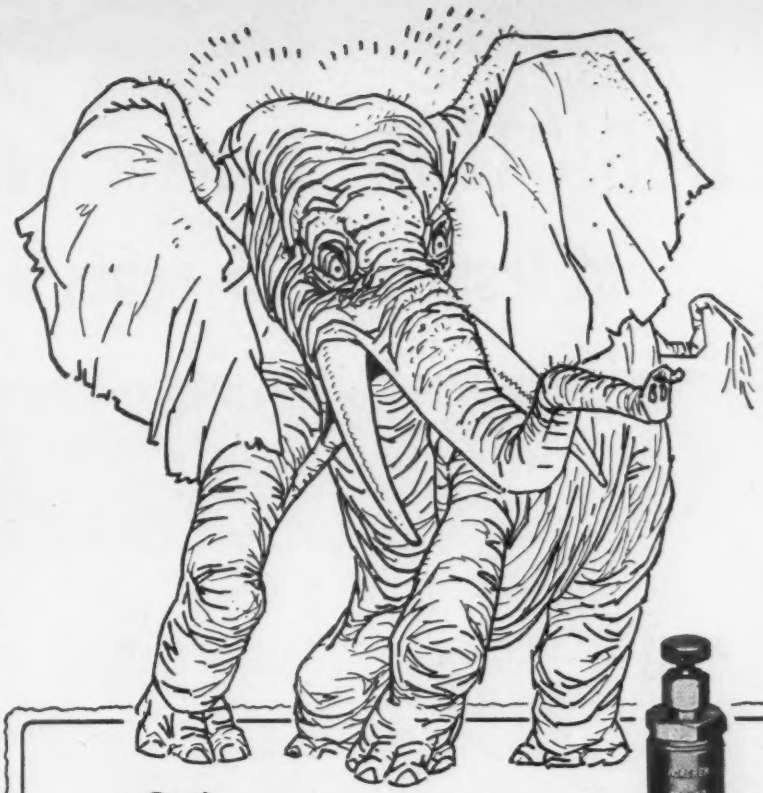
Instruments are further broken down into types, such as pressure, vacuum, temperature, quantity, flow, position indicators (flaps), flight, and tachometer indicators and transmitters.

The individual records maintained serve for more than mere indication of time and location of installation. Take Fig. 2 as an example. A certain make of tachometer transmitter is put into service, this one being located on No. 1 engine. An arbitrary overhaul time limit is set up, as based generally on experience with the type of unit. In this case a minimum time of 400 hr. was established, a desired time of 500 hr., and a maximum of 600. By the time the sheet is fairly well filled with noted overhaul intervals of the unit, with dates and airplane hours, a factual check can be made on suitability of the time limits chosen.

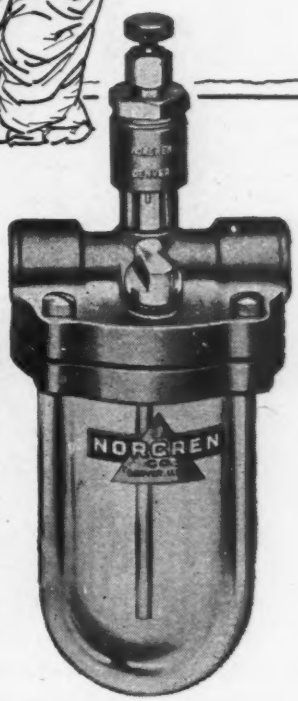
Here it will be seen that the average time between overhaul periods is 405 hr., indicating that the minimum of 400 hr. is a little too high. Although in a few instances the unit went far more than 400 hr., in more cases it had to be changed after a few hours, therefore the time limits would be revised accordingly.

In other cases the limit first chosen might be too low, and much additional service could be obtained from the unit in question. In all cases the records furnish the basis for accurate revision of time limits for all types of units in service.

The book of records as a whole serves as a supplement to the continuous master chart of the aircraft, and between the two, any item may be traced down. It will be noted that neither the master chart nor the individual record sheet illustrated indicate what was done to any unit, or what the nature of any difficulty was, but merely record times and routine checks. From these records any individual job or part may be traced to the shop records, where the work was actually done and the trouble involved can then be studied. If there were attempts to include everything, the master records would be far too bulky to be practical for checking purposes. Systematized as they are, every item, however



Never FORGETS!



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It packs a wallop! It insures maximum man-hour production . . . with minimum operator fatigue.

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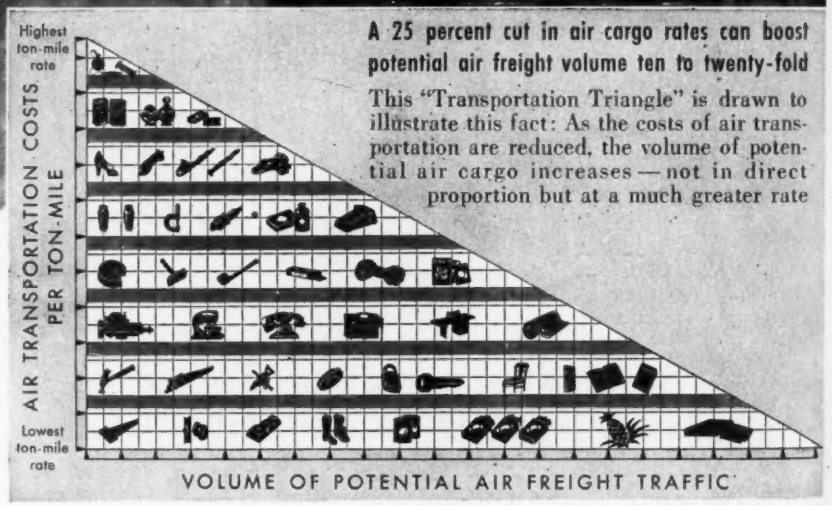
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A 25 percent cut in air cargo rates can boost potential air freight volume ten to twenty-fold

This "Transportation Triangle" is drawn to illustrate this fact: As the costs of air transportation are reduced, the volume of potential air cargo increases — not in direct proportion but at a much greater rate

AFTER VICTORY looms one certainty: Out of America's war-accelerated research will come new and different airplanes for a world at peace.

Airplanes so advanced as to make obsolete the newest and largest transports in the skies today.

Planes of new, unorthodox design—capable of carrying larger loads longer distances with greater economy in operating costs.

Giant land and seaplanes. "Shuttle" craft for short hauls. Express planes of incredible speed.

In these airplanes America's postwar products and American technicians will have the means to go fast and far to markets anywhere on earth—to unlock the world's commerce—and create new horizons for the better material welfare of us all.

Knowledge U. S. aircraft designers already possess is enough to guarantee this prophecy. For aircraft now on drawing boards can be operated profitably at rates below 15 cents per ton-mile. The rates for air freight before the war were from 80 to 90 cents per ton-mile!

With the coming of victory, Northrop accomplishments, together with those of other U. S. leaders, will contribute to a new world of peace and opportunity. A more desirable world in which to live.

Meanwhile all the resources of Northrop in plane design and plane construction are devoted solely to producing the planes of war. The planes that bring closer the day of complete victory for the Allies.

NORTHROP *Aircraft, Inc.*

NORTHROP FIELD, HAWTHORNE, CALIFORNIA

MEMBER AIRCRAFT WAR PRODUCTION COUNCIL, INC.

small, can be traced to its source in short order.

Propeller overhaul is performed with engine change at 600 hr. Routine inspection and service is, of course, done more often. Parallel to rotational overhaul of the ship itself, certain major operations are done on propellers at successive overhauls.

Although attempts were initially made to change all the engines on a plane at once and to keep their times together, they are now changed individually without regard to inter-relation of overhaul periods. It was found to be too long and difficult a job to accomplish all the work at once. Since engines are now removed, overhauled, and installed in complete interchangeable units, they are as easily taken care of as any other part on the ship.

Except for the hull and wings, very little repair is done on parts while installed on the aircraft. All control surfaces and hydrostabilizers are interchangeable among the 314's, and whenever repair is required on any one of these parts, it is removed and replaced by another unit, while the former part is repaired at greater leisure. Rudders and fins are interchangeable, right and left, as well as from one *Clipper* to another.

It is of interest to note that proper maintenance considerations were of such front line importance to sustained operations that engineering and maintenance come under one department at New York headquarters, both working for the same purpose. It is by efforts of this department that many of the improved maintenance features have been added to the *Clipper* design.

Interchangeability of hydrostabilizers mentioned above is an example of this. In order to secure an attachment of the desired tightness, these stabilizers were originally fastened by taper pins fitting into taper-reamed holes in hydrostabilizers and hull fittings. This required individual close ream fitting for each attachment, and if a unit were to be changed to another ship, a perfect line-up of parts was impossible to achieve without more careful reaming. If this exceeded certain close limits, all attachment fittings would have to be removed and replaced, with more individual reaming to follow.

To remedy this, all attachment holes have been straight bored in standard patterns in all units. Alignment is easily accomplished by means of expanding bushings, which in turn receive taper pins that secure all attachments to the desired tightness, and complete interchangeability without further fitting is assured.

In a large commercial aircraft where passengers put lavatory equipment to constant use, proper plumbing design is a major problem. Plumbing leading aft from the central water tank initially involved a particularly severe problem. As is customary with most manufacturers, piping had been run next to the skin where it is impossible to prevent freezing at high altitudes or in transition into cold climates. Since the pipes ran behind interior cabin coverings, bursting following freezing caused much damage inside as well as preventing use of lavatories.

To remedy the situation an auxiliary water tank for the after lavatory had to be installed directly over the lavatory, so that pipes were kept to the middle of the ship and all lines could be positively drained by gravity when desired, which is not true of the long lines from central location.

In coming north from tropical latitudes, enough heat is retained in the ship to protect the tank. Half an hour before arrival, the steward drains tank and lines to prevent damage from freezing.

Proper plumbing design for the special conditions of large airplanes is a very definite need on which nothing thoroughly satisfactory has yet been done. The natural tendency to locate the tank near the c.g. entails lengthy plumbing lines which bring special difficulties. Insulation does not seem to be sufficient in the way of protection, an improvement inherent in the design being required.

Another important improvement is in the electrical starting system and was

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The impressive record of Guardsman Finish and Guardsman methods for finish of ailerons and flaps for Aircraft Ambulances* shows these astonishing comparisons.

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Man Hours of Labor .	94 minutes	56½ minutes
Elapsed Time for Finish	254 minutes	26½ minutes
Material Consumed . .	9 quarts	5 quarts

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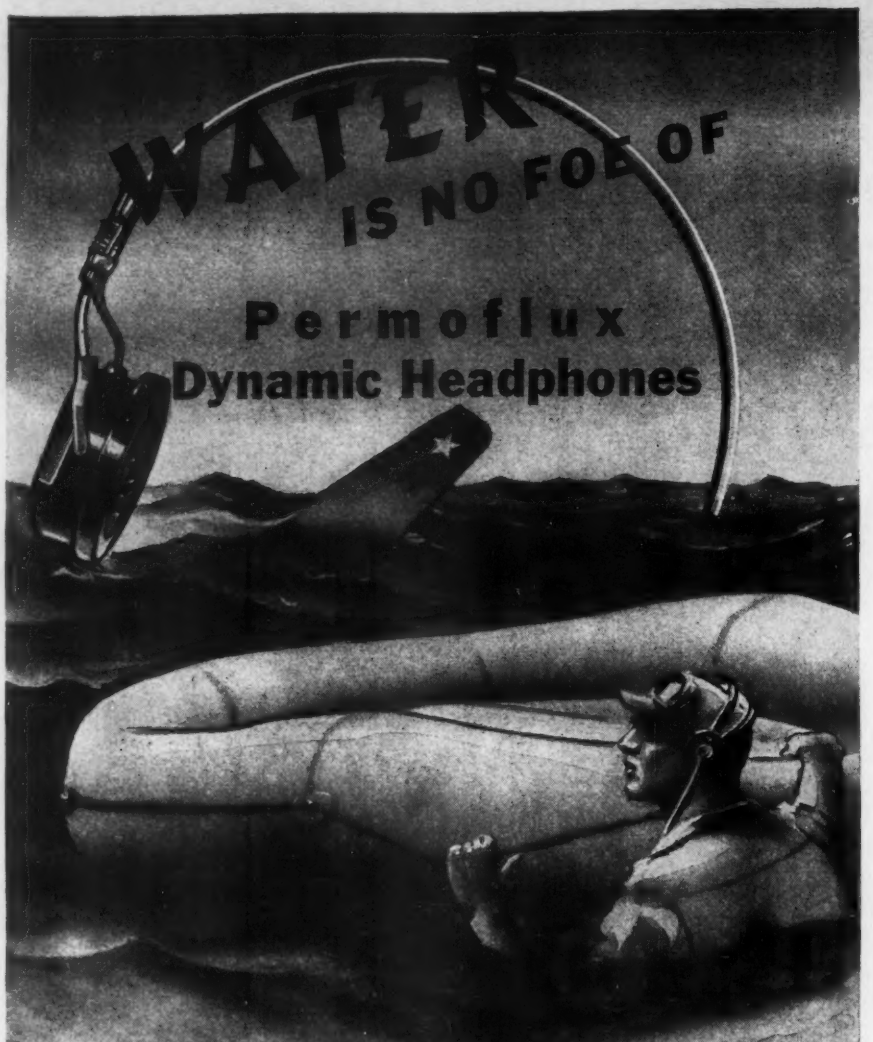

Even After Extended Submersion ...They Perform Again at Full Efficiency!

Because of their special hermetically sealed design, the outstanding performance of Permoflux Dynamic Headphones is not impaired by water, moisture or long hours of corrosive salt spray. And yet this same unique design allows instantaneous pressure difference compensation — an important, exclusive Permoflux development that assures higher sensitivity, more uniform frequency response and improved intelligibility at all altitude levels.

Permoflux craftsmen are turning out Dynamic Headphones in increased quantities for fulfillment of vital communications assignments.

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developed as a result of difficulty in cold weather. Original circuits included starter and booster coil energizing switches in one circuit. In starting with a very stiff engine, the voltage drop caused by the starter reduced voltage in the booster coil below effective limits. With separate switch buttons, booster coils and starters now maintain a full current flow to the coils regardless of starter conditions, so that the booster coil can deliver when most needed.

To improve accessibility to tail fin attachment fittings for inspection, the original one piece fairing has been divided in two and attached by means of quick fasteners instead of screws. Where formerly an hour or more was required to prepare for a five minute inspection, the preparatory job is now done in a few minutes. Accessibility is the key to most of these problems, and if it is not included in design, the operator has to build it in himself. The fruits of years of experience by operators provide the source for innumerable design improvements. The list of changes incorporated by PAA is too long to complete here, but it is hoped that these and other changes will sometime be given proper attention.

The department of engineering and maintenance functions in addition as an administrative unit, receives schedules for traffic, and apportions engineering, maintenance, and flight personnel to meet the traffic demands.

Procedures throughout the system have been coordinated by means of publications issued from engineering and maintenance. These are made out for each particular route, and they lay out service procedures in relation to the flight schedule for that route. When performed according to this plan, all flight time limits on equipment are automatically taken care of for the period between main base checks. For the latter, aircraft are routed to return to a main base within the prescribed check periods.

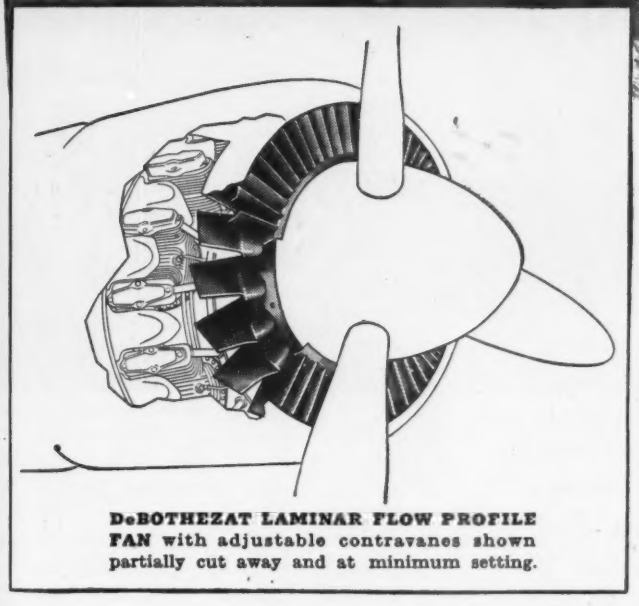
Publications are also issued on methods for carrying out maintenance procedures, for various routes where climate or location may involve special problems, and these publications point out things to be looked for to insure the greatest possible safety for these intercontinental links.

Super Aluminum Alloys For Aircraft Structures

(*Continued from page* 177)

tested in single-rivet (double-shear) coupons of 0.064 and 0.128 in. 24ST sheet. All the rivets were subjected to the rivet heat treatment of 945 deg. F. for 45 min., followed by a 65 deg. F. cold water quench. The 17ST rivets

Cool 'em with FANS



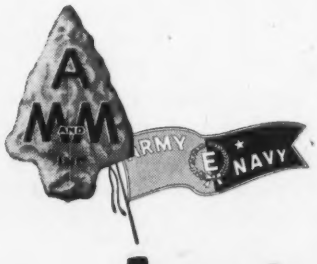
DeBOTHEZAT LAMINAR FLOW PROFILE FAN with adjustable contravanes shown partially cut away and at minimum setting.

OUT OF OUR DeBothezat laboratories for aerodynamic research now comes a new type laminar flow profile steel fan wheel adaptable to air cooled aircraft engine cooling. Chief features would be to provide: ***adequate and controlled cooling at all air speeds with reduced cowl flap drag—and increased effective horsepower.***

This fan unit may consist of adjustable contravanes and a fan wheel mounted directly behind the propeller. The adjustable contravanes provide controlled cooling at varying flight conditions.

This new fan development is the product of the engineering staff that successfully solved the problem of blast-cooling radial air cooled aircraft engines which are virtually "buried" in U.S. tanks.

DeBothezat's modern aerodynamic laboratories are ably staffed with skilled technicians experienced in solving numerous difficult engine cooling problems.



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BUY WAR BONDS AND STAMPS

Battleship of the Skies

You're looking through the waist gunner's window of a Boeing Flying Fortress*. . . at another Fortress on its test run near Seattle. Peaceful enough here, it nonetheless represents 32 tons of the most deadly fighting mechanism ever devised.

The Boeing Fortress now has a maximum bomb capacity of more than 10 *tons* . . . equaling or exceeding that of any other bomber, Allied or Axis, now in service.

Its stability and general flight characteristics make it a superior "platform" for high-level bombing of the most destructive accuracy.

The Flying Fortress has great defensive firepower and is credited with a remarkably high average of successfully completed combat missions.

All this, of course, is not just happenstance. It stems from the determination of the Boeing company nine years ago to build an airplane unlike any then in existence, an airplane that would be truly a "Battleship of the Skies."

To carry through such a project meant years of costly research. It meant continuing advancement from one stage to another, including long experimentation at stratosphere altitudes where few men had ever been. It meant utilizing the skills of many hundreds of engineers representing more than 25 different engineering fields.

It meant financial courage of a high order, for the original Flying Fortress was a wholly private venture financed throughout by Boeing.

Today Boeing's foresight and faith are more than justified by the outstanding record of Flying Fortresses in the war.

Tomorrow you may look to Boeing for peacetime products of equal leadership. The phrase "Built by Boeing" means they're bound to be good.

DESIGNERS OF THE FLYING FORTRESS • THE STRATOLINER • PAN AMERICAN CLIPPERS **BOEING**

*THE TERMS "FLYING FORTRESS" AND "STRATOLINER" ARE REGISTERED BOEING TRADE-MARKS

were driven immediately after heat treatment, while the A17ST rivets were aged four days at room temperature prior to driving.

It is suggested by the writer that the present ANC-5 shear allowables for A17ST, 17ST, and 24ST rivets, of 27,000 psi., 30,000 psi., and 35,000 psi., respectively, be revised upwards to give more nearly the typical values found in modern aircraft structures. It is also suggested that consideration be given to the use of 17ST rivets in the "hard" condition—even though some rivet-head cracking might occur—to gain a probable shear allowable of 40,000 psi. and over. The aging of large assemblies fabricated with 17ST rivets will no doubt result in additional increases over the "as-driven" shear values.

References

(For full list of references covering this series, see p. 304, Aug. AVIATION)

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(19) Tatman, M. E., and Weiher, E. R.—Unpublished CVAC Report No. SG-884, "Effect of Heat on the Physical Properties of 24ST and on the Color of Protective Coatings and Camouflage Finished," Apr. 1942.

(28) Mosley, P. P.—"Elevated Temperature Aging of 24S Aluminum Alloy." Paper presented before the Institute of Aeronautical Sciences, Los Angeles, Calif., Jan. 1943.

Wanted: A Haven For Aviation Securities

(*Continued from page* 183)

were found to be purchasers of TWA stock on the decline. This opportunity has not been present very often during the past year.

One of the surprises is the continued purchase of Northwest Airlines by Incorporated Investors. The trust, with total resources of more than $142,700,000, purchased an additional 450 shares of Northwest during the second quarter of the current year, bringing its total holdings in this—its only carrier—to 16,000 shares.

Total holdings of aircraft equities presents a pathetic picture. The deficiencies are present not so much in the meager commitments shown, but in the complete absence of those trusts which were present in the past in great strength, as is clearly shown in Table I.

The trend away from aviation equities is emphasized still further by the action of National Aviation Corp., a fund established to deal exclusively in aviation securities. Yet this trust apparently felt it advisable to "diversify" its investments in other industries. As a result, it asked and obtained its stockholders' approval to pursue such action and lost no time in doing so. The com-

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Throughout war industries today, Plomb tools of all kinds and sizes are helping build weapons to defeat the enemy. From the familiar screwdriver to intricate socket and attachment sets, outstanding performance and dependability have made them the choice of experts for better, safer, longer-lasting service.

These famous tools are available through the Plomb dealer in your community. Call him for the tools you need on your war job.

Remember Plomb performs a double service—consult Plomb Tools Contracting Company for special tools; call your Plomb dealer for regular ones.

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pany, as of June 30, 1943, increased its commitments in non-aviation enterprises to 12.6 percent of its total resources from 0.7 percent as of Dec. 31, 1942. Investments in aircraft manufacturing companies were reduced to 47.7 percent from 51.0 percent, and participation in the air transport industry was cut to 24.2 percent from 28.3 percent. This is a not inconsiderable loss.

Airlines Issues Reduced

During the first six months of 1943, National Aviation sold 17,200 shares of Curtiss-Wright, reducing its holdings to 7,800 shares as of June 30. Sales of 5,200 shares of Bell Aircraft and 6,800 shares of Grumman Aircraft were also made. Holdings of Douglas, however, were increased by 900 shares to a total of 7,900, and 500 shares of United Aircraft preferred were added, making a total of 2,100.

Almost all airline issues were reduced. Sales included 700 American, 3,500 Braniff, 3,000 Chicago & Southern, 800 Eastern, 4,500 Penn-Central, 3,000 TWA, and 4,900 United.

Certainly, if an investment fund organized primarily with the purpose of participating in aviation refuses to support that thesis, it may be difficult to expect other investment trusts to do so.

The aviation industry was recently evaluated from still another source: An Eastern investment dealer, specializing in the distribution of investment fund securities, surveyed the members of the National Association of Securities Dealers as to their opinions on favorite industries in the post-war period. The automobile industry was by all odds the first choice, chemicals were second, and airlines third. Similarly, the three industries considered least favorably situated in the postwar period were the machine tool, railroad, and aircraft manufacturing groups.

This type of appraisal is unlikely to make for much popularity toward the aviation industries among investment funds, and it might easily be construed as a re-affirmation of the policies shown in the liquidation of aviation equities.

It is highly possible that certain of the issues identified with the aircraft industry may receive a shot in the arm from another source. For example, "electronics" is the latest craze among the "growth" industries and is coming in for increased attention in the speculative crowd. During the past year, a flood of articles and advertisements have appeared extolling the techniques of electronics and their various applications. As a result, the widespread impression has been created that a new industry is being born. Actually, however, the basic techniques are far from new, but it is true that their utilities in sundry fields have received a powerful stimulus under wartime conditions. The coming of peace will see still further applications of this art.

Recognition of Electronics

Electronics deals with the origin, design, and installation of devices, all of which require engineering, together with the use of the basic electron tubes and related equipment. The development of electronic techniques has been, and will most likely continue to be, in adaptation to communication, transportation, and in the general industrial field. No new industry, as such, appears in the making.

It is easy to see how many established aircraft engineering organizations can turn their skills and talents to this new application. In fact, such companies as Bendix and Sperry have already been prominently mentioned as possible leaders in the greater recognition of this science. Other aircraft companies will probably come in for attention in due time.

Recognition of this new element may introduce new "glamour" to the aircraft industry, a factor which may some day contribute to renewed favor for aircraft equities on the part of the investing public.

When electrical parts and materials to be installed in planes must "go together" in service, there's a real advantage in "getting them together" from a single source. Responsibility is centralized, deliveries are more easily scheduled, "mis-fits" are avoided, paper-work is reduced.

GRAYBAR offers a specialized service to plane builders, supplying hundreds of the *approved* items you need for plane wiring, signaling, lighting and power supply.

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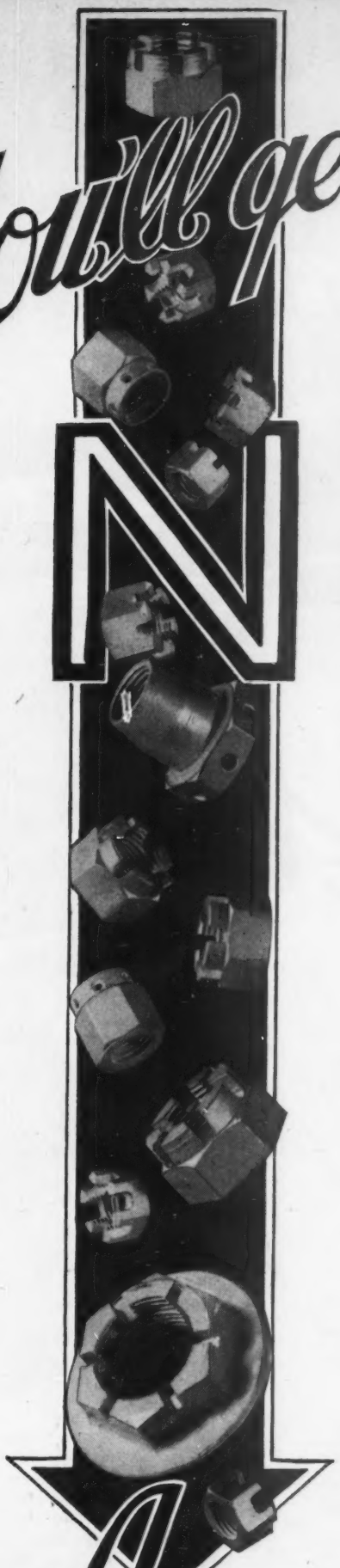

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Via WACO

Massing on West Coast shores—in the wings of the vast Pacific Theatre of War—are ever-increasing numbers of men and planes of the USAAF. Lest they miss their "on stage" cue, vital supplies from scattered base and depot must reach them—fast and unfailingly.

Much of this fast freight flys via WACO . . . yes, in a fleet of WACO standard, four-passenger, cabin planes converted to cargo service by Southwest Airways Company.

Carrying 1,000-pound payloads and logging 75,000 miles a month, these sturdy, pre-war WACOS have flown more than 100,000,000 pound miles without loss or damage in the first six months of operations . . . despite the rigors of eight daily flights in all kinds of weather over all kinds of terrain.

These ships were built in happier days to carry you and yours comfortably and care-free on your peace-time jaunts. Today, in performing war's grim missions, they are more than upholding WACO tradition for rugged, dependable performance . . . a tradition you can be sure will never die as long as WACO builds planes.

Converted Waco passenger models are used exclusively by Southwest Airways Co. in their feeder airline service which handles high priority and APOC shipments for the U. S. Army Air Forces. Waco's current war job is designing and building army cargo-transport gliders.

ALL ARMY CARGO-TRANSPORT GLIDERS ARE WACO DESIGNED

WACO AIRPLANES

THE WACO AIRCRAFT COMPANY · TROY, OHIO · U. S. A.

Lightning Brews Triple Trouble for Axis

(*Continued from page* 134)

and installing the LH. shearbeam plumbing assembly. The fairleads are to be attached to the fuselage webs. Connection with fuselage tubes will not be made until the next station. Another workman will assist part of the time and will lubricate the fittings and help attach the assembly to the shearbeam. See Item 9, also Item 6 Station 1643.

13. Install RH. Supercharger 1642-40R. Identical to Item 11.

14. Shearbeam Plumbing-RH. 1642-20R. Identical to Item 12. Also see Item 9.

15. Drop Tank Plumbing-1642-31R. Identical to Item 8.

16. Shearbeam Plumbing-RH. (assist). Identical to Item 9. Also see Item 12.

The nose landing gear is installed in the first station of the second leg, at the same time the outer wing panels are being hung. In the next station, at the same time the engines are being placed, the main landing gear links are installed, but the gear proper is installed two stations later.

Without attempting to detail the step-by-step installations and operations performed on the three legs of the final assembly line—377 of which are specifically covered by the *Job & Procedure Manuel*—some idea of the coordinating problems which have been solved is given, however, in the following listing of the main installations and operations in their chronological order on the new line:

First Leg: Rig main beam, install superchargers, air filters, and coolant radiators, close and seal main beam, hang and fit nose door, wire cockpit, fit boom doors, rig engine controls, install instrument panel, rig rudder and set stops, connect instrument panel, and install engine control rods and brackets.

Second Leg: Install nose landing gear, outer wing panels, oil tanks and main landing gear drag links, rig flaps, hang motors, test oxygen system, rig ailerons, install main landing gear, install oil system plumbing, check-out hydraulic system, install engine coolant systems, and complete electrical check.

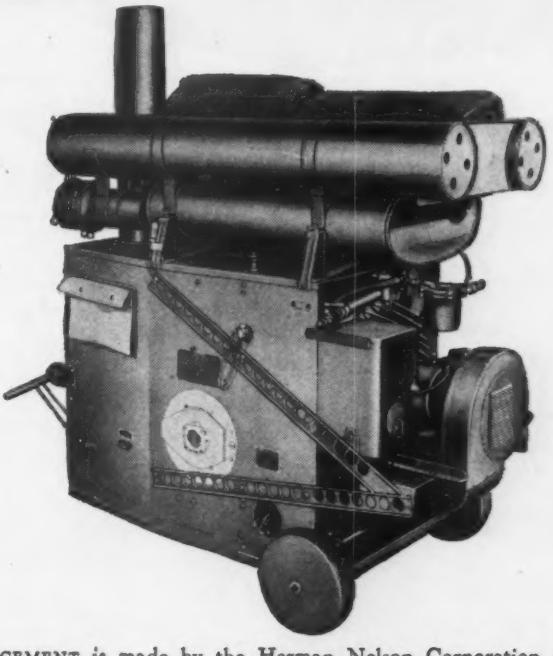
Third Leg: Install cockpit furnishings, close, seal, and Decal supercharger area, install ammunition trays and chutes, wheel well covers, inboard and outboard cowl panels, windshield panels, fuselage side panels, instrument panel armor plate, pilot's seat, cockpit hatch, bullet proof glass, tunnel webs, and dive fillets.

After the final check-out, inspection and necessary re-work of "squawks" in the last three stations of the line, the plane is towed on its own wheels to the camouflage shop.

Throughout the three legs of the final assembly line, continuous Lockheed inspections exert a constant control over the work and keep it up to specification. On critical items, Army inspection also keeps watch during installation as well as in the final inspection station.

The terrific expansion of the aircraft industry, coupled with essential design modifications, has prevented development of coordination to what might be called a precision point. The stage has now been reached, however, where volume becomes the keynote, something that can be attained only through giving the best tools to the worker on the job.

We feel we have taken the greatest step yet made by Lockheed in this direction in the installation of the new mechanized, continuously moving assembly line system. When the tributary line installations now in progress are completed, the flood-tide of P-38's this new system will pour out to the fighting fronts will add a spectacular chapter to the saga of U. S. industrial history. We at Lockheed sincerely hope that would-be dictators of the future will



ANNOUNCEMENT is made by the Herman Nelson Corporation of the availability for commercial use of a self-contained and self-powered, portable heater. This heater was originally developed by the company and manufactured for the Armed Forces for use in a wide variety of applications; the principal use being the pre-heating of airplane engines in cold climates and the heating of maintenance shelters and other types of portable structures.

Suggested commercial applications are the pre-heating of airplane engines for airlines; heating, drying and similar uses in building construction, shipyards, drydocks, etc., and as a portable source of heat to be used wherever required.

The device is direct fired and available in a model which uses gasoline for engine and heater fuel or in a model which uses gasoline for engine fuel and No. 2 fuel oil as a heater fuel. A small gasoline engine mounted as an integral part of the unit drives a pressure-type propeller fan which blows air over the combustion chamber and out through two 12" diameter openings in one end of the unit. The same engine drives a small centrifugal fan which provides air for combustion. Several models are available with various systems of collapsible, canvas duct work; the ducts being used to convey the heated air where required.

The Unit is equipped with two retractable wheels and when these are in a lowered position the unit can be moved in the manner of a wheelbarrow.

The unit is approximately 26" wide, 56" long, 42" high and weighs only 290 pounds without ducts. Heating capacity is 250,000 B. T. U.'s per hour at 60° inlet. Discharge against ½" W. G. is 2000 cubic feet per minute.

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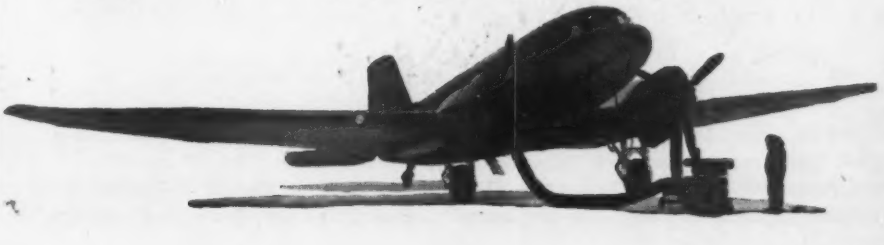
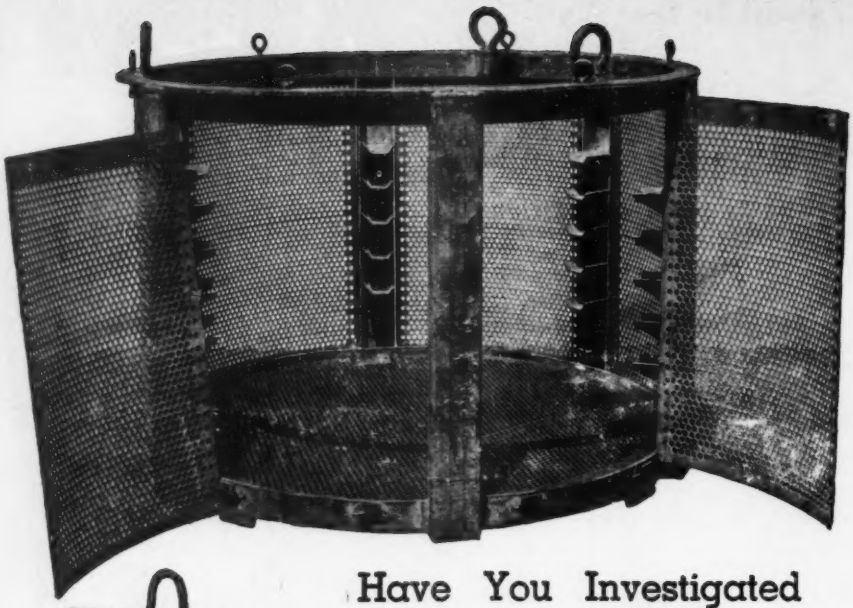
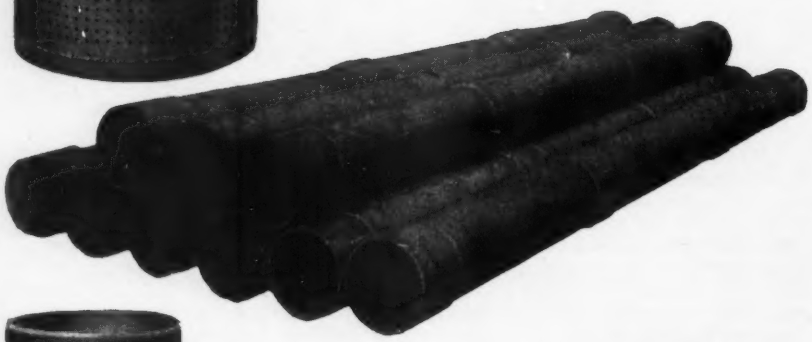


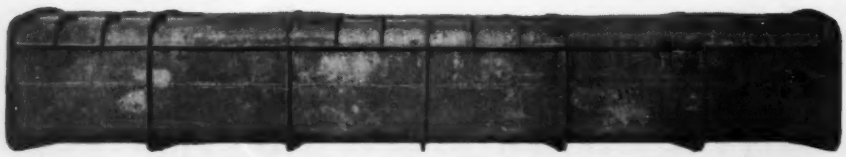


Have You Investigated the Possibilities of Pressed Steel Company

CARBURIZING and ANNEALING EQUIPMENT?



We Specialize in the Manufacture and Welding of all types of Alloys



THE PRESSED STEEL COMPANY
of WILKES-BARRE, PENNSYLVANIA

DETROIT: 337 Curtis Building • TOLEDO: 606 Nicholas Building
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PRESSED STEEL COMPANY PRODUCTS: Carburizing and Annealing Boxes, Thermocouple Protection Tubes, Seamless Steel Cylinder Caps, Seamless Steel Neck Rings, Welded Alloy Tubing for High Temperature and Corrosive Application, Radient Tubes, Inner Covers and Base Sheaths for Steel Mills

not make the fatal mistake of current ones when they base plans of conquest on the assumption that the United States is potentially big and strong, but can never get into big production soon enough. Large volume manufacture of *Lightnings*—suddenly doubled and which may be tripled in a matter of weeks—is further proof to the contrary.

Cruise Control For Flying Efficiency

(*Continued from page* 207)

Another variable which has not yet been taken into account is the effect of a change in the fuel/air ratio. There is a mixture at which best power is produced for each combination of rpm., manifold pressure, pressure altitude, and air temperature, any variation from which will reduce the engine power. This problem is taken into account by making up a set of power curves for each mixture condition usually encountered, the most common being "auto lean" and "auto rich." The curves usually referred to are from "best power mixture."

The standard pilot's power table for Wright G-102 engines is shown in Fig. 4. In constructing such a table, a decision must first be made as to operating b.m.e.p. which is usually decided by the operator in conference with the manufacturer. A b.m.e.p. of 140 lb. psi. was chosen for the basis of the table in Fig. 4. Selection of this factor establishes respective rpm's. according to hp. At high altitude, the required manifold pressure may not be obtained at the specified rpm., and an increase in rpm. must be specified in order to obtain the desired hp. Such operation is known as full throttle condition.

The altitude factor is presented on a pressure altitude basis according to the anticipated operating altitude range of the engine. Manifold pressures (standard temperature) for horsepowers and altitudes are determined from the basic power chart and presented as shown in the table. The temperature effect on power output is accounted for by the subnote on manifold pressure and throttle adjustments in accordance with carburetor temperature variations from the standard. Under peculiar circumstances it may be desirable to use other than these standard rpm's.

The power calculator shown in Fig. 5 is a simplified method of giving the information of the power chart and of rpm. selection in power control without the use of charts or formulas. The calculator has a use in determining what manifold pressure is required for a specified hp. at a certain rpm. under existing altitude and temperature conditions. Temperature correction of

WILL POSTWAR AIRLINERS FLY THESE LEVELS?

30,000 FEET

25,000 FEET

20,000 FEET

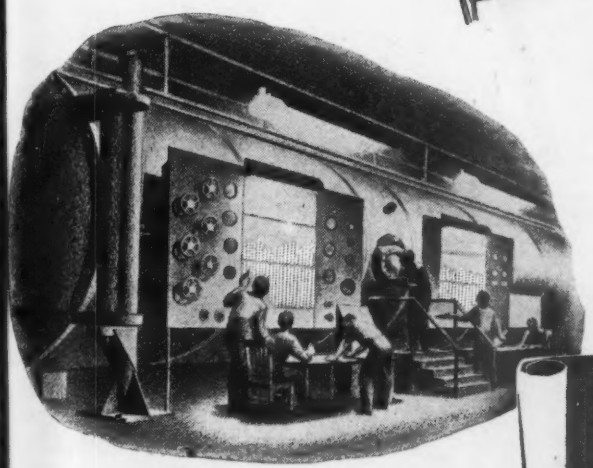
15,000 FEET

"It's something airline operators are looking forward to." Flying the higher altitudes will step up speed... cut fuel consumption... make possible smoother flights above storm conditions.

Up to now, passenger comfort has set the ceiling. For above 8,000 feet, most people's ears begin to pop. Above 10,000, they become sleepy and dizzy. These discomforts—due to lowered air pressures—must be overcome before passengers will take to high-altitude air travel.

Pressurized cabins will pave the way

They will eliminate these discomforts by *holding pressure constant* during take-off and descent. They will *adjust pressure* gradually during flight from low to higher altitude airports. They will even be able to hold sea-level altitude in the cabin while the airplane flies thousands of feet higher.



MUCH of the development work on cabin pressure control has been carried on here in the AiResearch "Stratolab". Our engineers have created altitudes as high as 65,000 feet—temperatures below minus 90° F. And they've found ways to control them!

The success of their engineering now assures pressurized cabins for postwar airlines. Information is available to aircraft manufacturers and airline executives.

AiResearch
MANUFACTURING COMPANY
LOS ANGELES • PHOENIX
DIVISION OF THE GARRETT CORPORATION

"Where Controlled Air Does the Job" • Automatic Exit Flap Control Systems • Engine Coolant Systems • Engine Oil Cooling Systems • Engine Air Intercooling Systems • Supercharger Aftercooling Systems

power is the primary step in the use of this calculator, determining the power under standard conditions, from which the power under existing conditions is found. For example, suppose that 600 hp. is desired and the air temperature is 26 deg. F. below standard. In this power range a temperature change of 36 deg. F. indicates a 22 hp. difference in power. Therefore, under standard conditions the engine should be set for 578 hp., resulting in an output of 600 hp. under actual conditions. These temperature-horsepower differentials are shown on the back of the calculator (seen at right in Fig. 5).

The face of the calculator is a basic power chart at standard temperature. The sloping edge of the case represents the altitude effect on power output. In use, the sliding altitude diagonal must intersect the desired horizontal power line, when the conditions of manifold pressure and rpm. can be read upward along the altitude diagonal. The rpm.-manifold pressure condition at the intersection of the horizontal power line and altitude diagonal represents the full throttle condition at the respective altitude and hp.

Suppose a pilot desires to cruise at 600 hp., 1,850 rpm. at 5,000 ft., with outside air temperature at 68 deg. F. According to the standard temperature chart and hp. correction chart, he should set his calculator for 618 hp. Setting the altitude diagonal line for 5,000 ft. and 618 hp. he reads that at 1,850 rpm. he requires a manifold pressure of 28.5 in Hg. Had he desired 1,950 rpm., he would have found a manifold pressure of 27.84 in Hg. was required.

It would appear that further simplification and increased accuracy of power control must await the more precise development of the horsepower meter, torquemeter, or thrustmeter.

GLOBE HYDRAULIC HOISTS SPEED PLANE HANDLING

for Manufacture, Modification and Servicing

Where Globe Hydraulic Airplane Hoists are in service—in assembly hangers, modification centers or service shops—the free wheeling of a large bomber or transport plane is only a matter of minutes. Installation and servicing of landing gear mechanism and tires is made easier and quicker.

With Globe Hoists spotted under the two wing jacking pads and the tail (or nose) pad, a plane can also be raised easily to actual "flight position" for accurate checking and calibrating of instruments, armour and controls.

Many leading plane manufacturers and airline operators have found the answer to their particular plane-handling requirements in the wide choice of types available in the Globe line. One of the most popular and versatile is the Type A-70 Portable Hoist illustrated in use below. For a folder on all types of Globe Airplane Hoists and the new Globe Airplane Wheel Dolly, write Globe Hoist Co., Mermaid Lane at Queen Street, Philadelphia 18, Penna.

TYPE A-70
• Compression-spring-mounted wheels make Hoist portable... permit entire base to engage floor under load.
Max. lifting capacity, 21,000 lbs.
Hand screw adjustment . 30"
Power lift . . . . . 27⅝"
Maximum height . . . . 111"
Approximate weight, 1750 lbs.
Power: Electric or gasoline motor
GLOBE
HYDRAULIC AIRPLANE HOISTS

GLOBE HOIST COMPANY
Philadelphia, Pa. Des Moines, Ia.

What the Postwar Buyer Wants

(*Continued from page* 117)

comfortable, and simpler to control. These refinements were indicated, in the two surveys, as desirable.

On numerous occasions the author has been criticized for raising the specter of the hazards of private flying. This specter has been a constant challenge to our progress in the past and will continue to be so in the postwar era unless we put it down. If they had no other justification, changes to reduce hazards of flying could be advocated solely on the basis of their affect upon the costs which have been indicated as the greatest factor in causing people to give up private flying. Reduction in hazards means reduction in accidents, in the cost of subsequent repairs, and in a decrease in insurance rates. And for the prosperous flying prospect, the consequent reduction in extra life insurance premiums could possibly make the difference between acceptance or rejection of ownership.

Changes which reduce hazards would also justify reduction of regulations. Table 2 reveals that the extent of regulations was an important item in causing plane owners to sell. The weight given to this item is doubly significant because it was not listed in the questionnaire but added by so many of those answering that it could not be put in the miscellaneous column.

Possibly the extent of regulation could be reduced by change in policy. But in the past, efforts to secure such a modification seem to have been unavailing. If policy is not to be changed, then the only way of reducing the regulations is to reduce the accidents which make them necessary. The record of the causes of fatal accidents in 1938, the last year before the start of the Civilian Pilot Training Program, was: Stalls and spins 51.1 percent, collisions 17.7, takeoffs 9.4, landings 4.7, miscellaneous 17.1.

This record is typical of previous years and is an eloquent plea for air-

planes as stall- and spin-proof as possible. It is useless to contend that modern airplanes are difficult to put into a spin. Stall and spin accidents in 1939 were not confined to old and obsolete airplanes. And it is this record that determines the cost of repairs and insurance premiums.

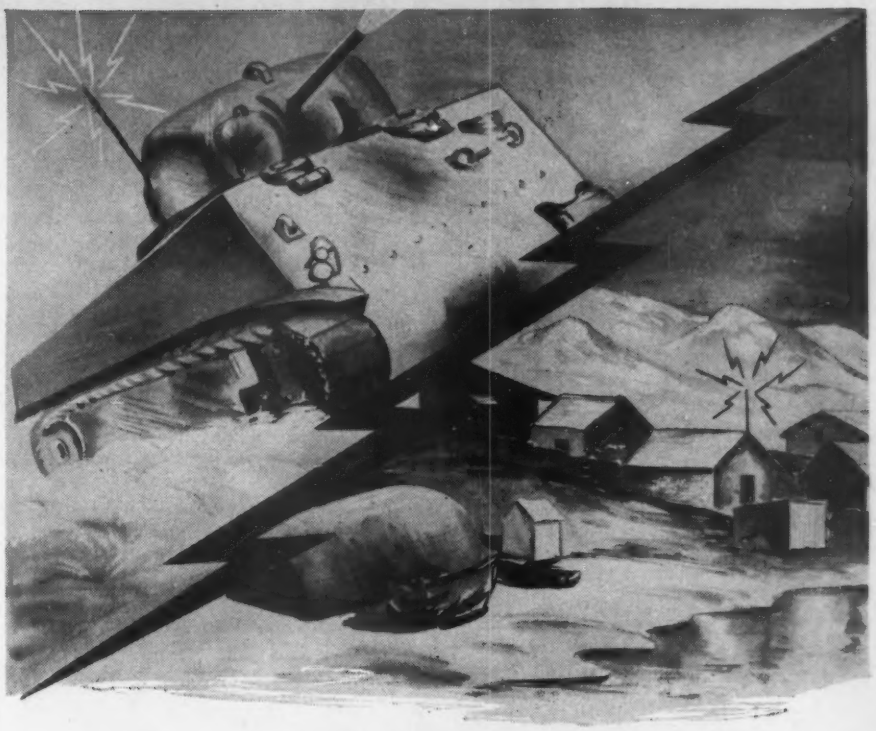
Next in causes of fatal accidents are collisions. As the density of private flying increases, the percentage of accidents due to collisions will also increase unless we either improve our planes or accept still more stringent regulations. Density might be reduced by the construction of numerous flight strips in place of single airports. Accidents could also be reduced drastically by providing better visibility for the pilot, for practically all density accidents occur when one plane is in the blind spot of the other. One of the requirements in the Bureau of Air Commerce safety airplane competition in 1934 was improved visibility for the pilot. The winning design, the Hammond, met this requirement.

Good visibility is also required for greater comfort and pleasure in private flying. Furthermore, it makes avigation much simpler, since all landmarks may be seen in relation to each other.

Next cause of fatal accidents were takeoffs and landings. Letters from Hammond owners indicate that landing accidents can be reduced. Some owners expressed the belief that they could make forced landings with a greater degree of safety than in other types of airplanes. Others actually described making forced landings which they were convinced would have resulted in serious accidents in conventional planes. Excellent visibility was undoubtedly an assisting factor.

Although there was no indication in these letters that there might be a reduction in accidents during takeoff, the author's personal experience leads him to believe that this would be true. A major reason is the decrease in distance required to bring this airplane to a stop from flying speed when a stable undercarriage is used. This permits a pilot to approach closer to an obstacle before deciding whether or not he can clear it.

Next to safety the author puts comfort. Attention has already been called to the fact that past owners wished to sacrifice speed for more comfort and to the increased comfort obtained by improving visibility. However, the most important change for comfort is believed to be reduction of noise. In a recent survey made by one of the larger airplane manufacturing companies among private pilots in their employ, 50 percent stated that their wives or families did not participate in their flying activities. It is not known whether any of these pilots owned their



In DESERT TANK and ATTU SHACK...

Crystals guard men's lives!

It's a far cry from the sweltering oven-interior of a jolting tank doing desert patrol duty to the comfortless shack on the bleak windswept tundra of an Aleutian outpost . . .

Yet, in both, men's lives may depend on the exacting skill of a girl they never saw!

For, by her painstaking work is made the tiny crystals without which they could have no communication with the outside world. Crystals which, if not unfailingly perfect, might leave them unforewarned of danger . . . and death.

At Scientific Radio Products Co., that need for perfection is never forgotten for a moment. The big share of those perfect crystals go to Uncle Sam. But our facilities are such that we can take care of your important needs, too. Write us, if we can help.

Scientific RADIO PRODUCTS CO.

738 W. Bdwy. Council Bluffs, Iowa

LEO MEYERSON W9GFQ
E. M. SHIDELER W9IFI

MANUFACTURERS OF PIEZO ELECTRIC CRYSTALS AND ASSOCIATED EQUIPMENT

own planes. But if so, the number was probably small as few men would purchase a plane if their families could get no pleasure from it.

Past Record No Proof

All of the changes considered above have been made or proposed in the past, but they were not generally accepted. Some people will contend that the fact that they weren't accepted is sufficient proof that they were not wanted. However, the entire history of technological development belies any such contention. Two familiar examples are the stable undercarriage and the "safety" airplane.

The tricycle landing gear was used on some of the earliest airplanes, then was discarded. When the Development Section of the Bureau of Air Commerce fostered its revival, many prominent figures called the action pure folly. Had the Section been swayed by their arguments, the tricycle gear carriage might not now be serving so well in several leading aircraft types.

The development of the safety airplane was fostered in the Guggenheim contest in 1929. The fact that the winning craft in this competition were never marketed was presented as an argument against the Development Section's advocacy of stall- and spin-proof craft, and the past record was called proof that the public did not want such airplanes. Later the failure of the Stearman-Hammond Co., producers of the winning design in the Development Section's contest, was cited as a confirmation of the original contention.

Production of the Hammond was apparently discontinued primarily because of lack of sufficient working capital. Engine trouble was a contributing reason. That a lack of public demand for airplanes of this type was responsible for the manufacturer's failure seems doubtful, judging from letters from Hammond owners.

Replying to a letter asking his reactions to the plane, one flyer wrote: "I find that there is a tremendous interest in the Stearman-Hammond type of airplane and that just as soon as a ship of this type can be built to sell within the price range of the majority of people, there will be a sudden influx of activity in private flying."

That such estimates were not wrong was well proven by the subsequent acceptance of the *Ercoupe*, a similar safety airplane sold at a lower price. Its manufacturers could not fill the demand even when materials were readily available.

This article would not be complete without reference to the helicopter and the implications of the public reaction to it. These reactions confirm all that has been said about our potential market. Certainly no other vehicle has created such a wide-spread public interest and none has offered so little airspeed.

The potential postwar customer has been fascinated by the helicopter, for he wants the ability to land and takeoff closer to his point of departure and point of destination, he wants to be less restricted by bad weather, and he wants greater safety. He does not demand 120 mph. cruising speed.

If we give the safety and comfort he wants, he will become a steady customer. If we offer him only the excitement that the boy at the airport wants, he will not.

Once upon a time there was a little "Jeep"—but the rest of that story needs no telling, for no one piece of war equipment has won undying fame so quickly, nor endeared itself to the hearts of all fighting men than has the "mighty midget" shown above. But—take another look—for just above it is another already famous Jeep, the Jeep with wings, the "skeeter-bug" of the air.

This miraculous new Army plane is the Sentinel, or "Flying Jeep," perfected and produced by Consolidated-Vultee's Stinson Division at Wayne, Michigan. This is the plane which has become as integral a part of the U. S. Field Artillery as the big guns which roll into position beneath it. It is the "eyes upstairs" of all Army Ground Forces. It is the "finger man" that is putting the Japanazi gangsters on the "spot."

Any manufacturer would be glad to play even a minor part in the contribution which planes such as the incredible Sentinel are making to Victory. That's why here at McAleer, working round-the-clock, we feel humbly proud to deliver in volume many of the surface assemblies which go into the "Flying Jeep." We feel privileged in being selected to add our efforts to America's tremendous plane producing program.

Tomorrow's world of flyers and plane builders will find McAleer airminded in the fullest sense of the word.

Military aircraft assemblies alone are not all of the war products of the McAleer Company; there are others which extend into and virtually cover the fields of military pyrotechnics and hydraulics—yes, and embrace our complete industrial finishing facilities as well.

May We Put Our Shoulder to the Wheel You Are Turning on the Road to Victory?

McAleer MANUFACTURING CO.
Quality-Controlled Finishing Materials
ROCHESTER, MICHIGAN

Banana Run

(*Continued from page* 115)

matter of a few days. For soldiers who have been on jungle duty for two, three, and sometimes four years, there is nothing more desirable than "mail from home." And, since most soldiers seem very serious about maintaining what they call "civilian morale," sending letters home from their outposts in short order is one of those intangible yet invaluable things in protecting this "civilian morale."

Remainder of the cargo was true "hot freight," ranging from replace-

3 Shift Endurance Builds More Planes

ools Must Work EVERY Shift

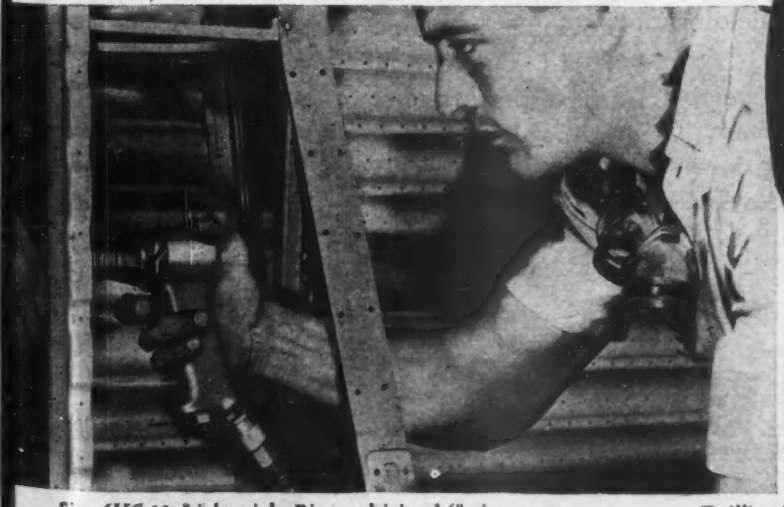
is endurance feat is being performed every day thousands of Ingersoll-Rand pneumatic tools the aircraft industry. Only a brief time-out for riodical lubrication and inspection is necessary keep these vital tools on thé job.

Why I-R Aircraft Tools are Used

re power per pound • Low air consumption
al for close quarters • Light weight
ll balanced • Easier handling • Less fatiguing
Ideal for women operators

Size AVC-13 Lightweight Riveter Driving ¼" rivets.

Ingersoll-Rand and its employees are proud of the Army-Navy "E" awarded to its Athens Plant for high achievement in supplying essential war equipment.



Size AVC-10 Lightweight Riveter driving ⅛" rivets on a center section frame.

Drilling 3/16" holes in a nose section with a Size OL "Multi-Vane" Drill.

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After V-day . . . many of electronics' wonders will be serving on our airways . . . making navigation surer . . . flight safer . . . travel more convenient. And because so many of these developments will depend on perfect signal reception, ignition shielding will play an increasingly important role.

That's why *continuing research* and *development* is a *major* program at TITEFLEX. Already it has contributed many outstanding shielding developments such as the *Unimold lead . . . developments aimed to make ignition shielding electrically leak-proof . . . mechanically fool-proof.

Today, this intensive TITEFLEX research and development on ignition shielding is focused on providing increased safety for our battleships on the air. But for tomorrow, it promises new standards of performance for our great transports flying the peaceways of the world. Titeflex Metal Hose Co., 510 Frelinghuysen Avenue, Newark 5, N. J.

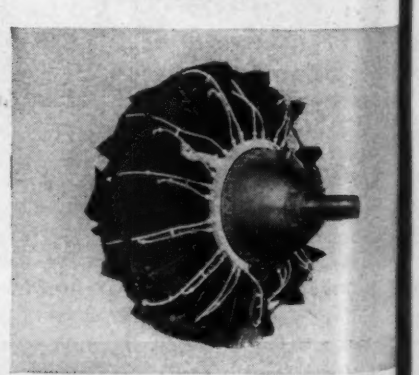
*Reg. U. S. Patent No. 2,123,16

ARMY E NAVY

Titeflex

REG U S PAT OFF.

RADIO SHIELDED IGNITION HARNESSES



RADIO, POWER, AND IGNITION SHIELDING — HIGH PRESSURE FUEL, OIL, AND AIR LINES — CONDUIT, FITTINGS, COMPLETE ASSEMBLIES

ment parts for keeping fighters, bombers, and patrol planes in the air, through bombardiers' enclosures for four-engine bombers, to a sorely needed part for a fighter plane which had been forced down during a long delivery flight.

Even before the climb to the altitude prescribed by the flight plan had been completed, the east coast of Mexico had disappeared beneath the right wing, for Banana Run takes the shortest route. It isn't, however, any harum-scarum operation, because regular airline safety procedures are followed throughout, something which surprises most of the student pilots assigned to it.

Some of these student pilots, just graduated from Army Flying schools, feel let down on being assigned to ATC; they think of themselves as hot fighter pilots who should be out at the front shooting down *Focke-Wulf 190's* or Jap *Zeros*. But a few weeks of the concentrated "enroute" training they get under the transport transition program, conducted by ATC with the full cooperation of the airlines and the Airlines War Training Institute, convince the young lieutenants there's more to flying a cargo plane than meets the eye. By the time they have made their first trips as observer, most are completely sold; they realize it may not be as easy to garner medals on cargo runs, but such jobs are absolutely necessary to win this war.

This doesn't mean there are no citations for ATC crews. War Department records show plenty. It's just that such awards only come from extraordinary achievement, which is something coming from an outfit like ATC which considers world-girdling flights mere routine.

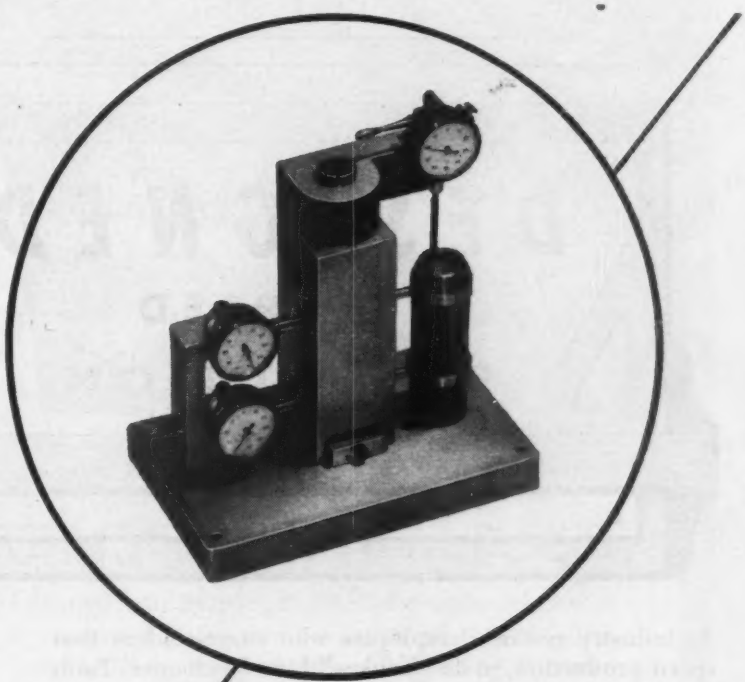
In this training field, Banana Run has proved particularly valuable, because the terrain and weather are very similar to those found in some areas where our supply problems are toughest, areas where airpower is certain to be the deciding factor in putting the Japs where they belong. Both terrain and weather are, as one student put it, "slightly rugged." This correspondent was forced to agree, particularly on the weather. Trying to snatch 40 winks stretched out atop the mail sacks, he suddenly found himself counting rivets in the top of the plane. And then, just as suddenly, he learned the hard way that the floor was really solid.

This "slightly rugged" weather lasted for a good stretch, but it presented an excellent opportunity to study cargo tie-down methods, for not one of the many odd sized and shaped cases or sacks shifted position. It also gave the student pilot an excellent opportunity to polish his instrument flying—as the run often does. Many times as much as 50 percent of a day's flying will be on instrument.

A good chance to study the ruggedness of the terrain was also provided as "82" let down for a re-fueling stop at a jungle outpost on the west coast of a Central American country, both of which must remain anonymous. Only part of the post visible from the air was the one long hard-surfaced runway slashed out of the thick undergrowth, which followed it right to the beach. But once on the ground, there were glimpses of the dispersal areas, each with a fighter or attack plane, either on duty there or being delivered by ferry pilots.

The outpost base itself was a strange admixture of the civilian and military. Since it was a military base, it had a military representative of the country to serve as liaison officer with the American Air Forces officer in charge. There were, however, customs and immigration representatives, as well as a representative of Mexico occupying the same position as the official located at the northern end of the line.

Use of this base, a recent change over, brought a vast change to Banana Run's



SPECIAL GAUGES
by TURNER

Illustrated above is a Special Gauge made by Turner. This gauge is just one of the hundreds of Special Precision Gauges Turner makes for manufacturers who require their own particular type of gauge to check certain precision operations on their production lines. Turner's Engineering Department has played an important part in assisting in the design of these gauges and the Turner Company invites you to write them if you have a checking problem that requires a special built gauge.

TURNER BROTHERS

TURNER GAUGE GRINDING COMPANY
2627 HILTON ROAD . . . . FERNDALE, MICH.

operations. Originally the schedules called for an overnight stop for both planes and crews at an interior city of 5,000-ft. elevation, closely surrounded by mountains. With the shift to the sea-coast base, however, schedules were changed so that only crews stop over night. Crews which had made the first leg of the trip the day before then take the planes right on through, which means the aircraft make the 2,000 mi. trip in one day. It has meant more than 12 hr. per day plane utilization and has practically doubled the run's load carrying capacity.

The visit to the base was short, for the white-starred olive drab fuel truck was in position as soon as the engines quit running. There was, in fact, just time to walk to the Post Exchange (operated by a native youngster) for a "chiss" sandwich and the inevitable Coca Cola—and to acquire a Grade-A sweat just by being alive.

Terrain and weather on the second half of the day's run continued "slightly rugged," but both were forgotten with the approach to the Caribbean Defense Command zone, where the radio operator reported position via the day's code and the pilot took the plane to the altitude prescribed by that code. Suddenly, from nowhere it seemed, there were squadrons of fighter planes alongside giving "82" the once over, checking her identity. For an American it was a most comforting sight—repeated constantly to the Zone itself—and just one more reason to be glad one wasn't a Jap, especially one trying to fly through that cordon to get at the Canal.

Arrival at the Zone, right on schedule, was as routine as the arrival of a liner in this country. The other planes had already been unloaded. By the time passenger-arrival formalities had been completed, "82" had also been unloaded and was in the hands of the maintenance crew.

Since first, second, and third echelon maintenance are regularly done at the northern end, the crews stationed at the Zone have confined themselves largely to 10- and 15-hr. checks. Normally they require little or no repair facilities, but all those of the Panama Air Depot have been made available if necessary. Banana Run officials are high in praise of the cooperation received from the Air Service Command, which works in close liaison with ATC throughout the world.

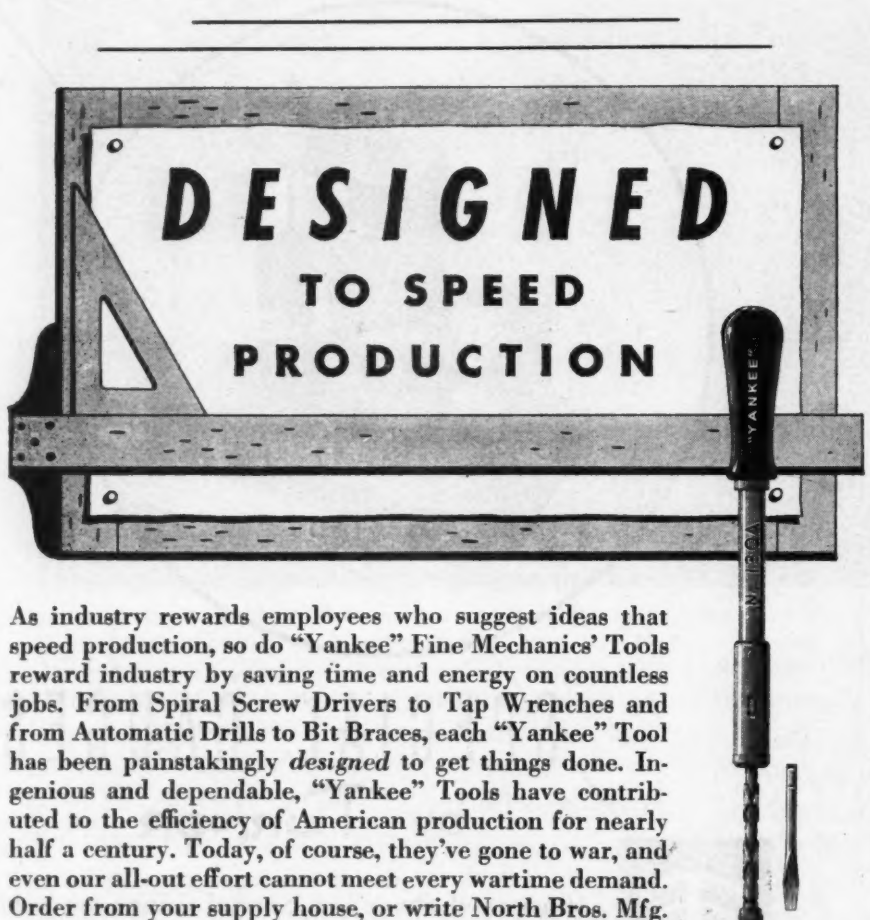
Once, for example, an emergency engine change was necessary. Within 30 min., ASC had procured an engine and opened its repair hangar for the change; which meant a cargo plane was delayed only a matter of hours instead of days or weeks.

Although not originally designed for the purpose, the building occupied by ATC has proved exceptionally well fitted for the job to be done, since accommodations for cargo, mail, and passengers have, with very few alterations, been made possible under one roof.

Separate quarters have been set up for the 15-odd employees handling nothing but mail, which has become such a vital part of operations that 1,000 lb. of capacity in one of the northbound planes is allocated each day for service mail. Since the flow of strategic materials moving north has been lighter than the hot freight moving south, this weight-space can be set aside without hampering the line's over-all efficiency.

Truck-high docks have been built within the building—originally built as a storehouse—to simplify cargo handling for the various route stations, which have their own sections marked off by signs. Here, as at the other end, specially-trained crews under ATC supervision make short shift of loading and off-loading.

North-bound passenger travel is heavier than south-bound, for Banana Run literally becomes a mercy-run, since the majority of its passengers are service men getting back to the "States" for the first time in three to four years. Because of this heavier traffic, routine varies from that applying to south-bound passengers. (*Turn to page* 320)



As industry rewards employees who suggest ideas that speed production, so do "Yankee" Fine Mechanics' Tools reward industry by saving time and energy on countless jobs. From Spiral Screw Drivers to Tap Wrenches and from Automatic Drills to Bit Braces, each "Yankee" Tool has been painstakingly *designed* to get things done. Ingenious and dependable, "Yankee" Tools have contributed to the efficiency of American production for nearly half a century. Today, of course, they've gone to war, and even our all-out effort cannot meet every wartime demand. Order from your supply house, or write North Bros. Mfg. Co., Dept. MMS-943, Phila., Pa. Furnish priority ratings whenever possible, and every effort will be made to fill your orders.

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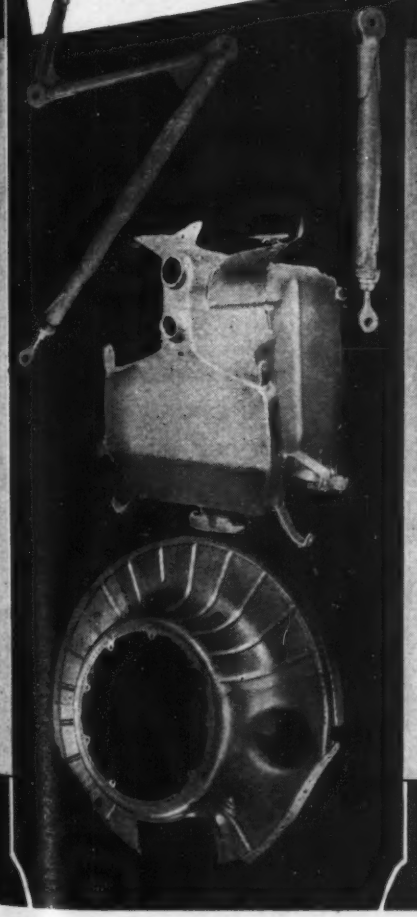

MISSION COMPLETED

From Hamburg, from Naples, from Salamaua another war bird of democracy returns safely to report "mission completed." And playing its part in the safe landing of many of America's greatest bombers as they return from mission after mission is the precision built Guiberson flap track support. Dependable flap operation helps make the homecoming easier, surer, safer. The problem of building the best flap track supports for America's finest bombers has been one of the tough problems of the industry but today it is simply another "mission completed" by Guiberson—the problem that has been solved by the engineering ingenuity and manufacturing skill that is embodied in every Guiberson precision built product for the aircraft industry.

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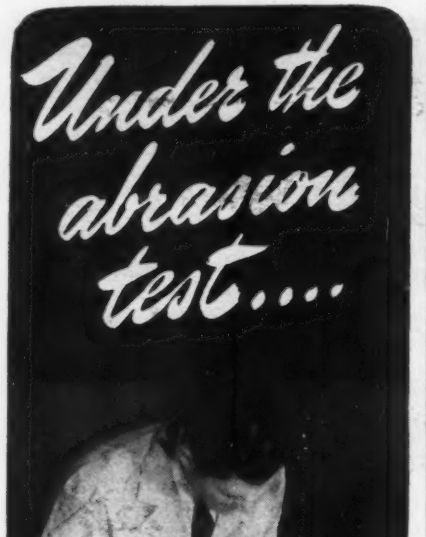

"AT THE end of 5000 cycles of rubs—felt against felt and 2 rubs per cycle—the eighteen Booth felt specimens were measured for wear. Only 4 specimens showed greater than 3.4% decrease in thickness; and 5 showed less than 2.0%."—From lab. report.

Abrasion-resistance is but one of the many characteristics closely controlled in the manufacture of Booth "prescription" felts.

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2072

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PRECISION CUT FELT PARTS

Again the scheduled departure was at a decent GMT hour, but it was a wee sma' hour of an Eastern Standard Time morning. Nevertheless, passengers reported a full hour before take-off time and, with their baggage, were carefully weighed. When total passenger load had been figured—and the passengers themselves had gone to a near-by post restaurant for breakfast and varying sized sacks of sandwiches—the plane was loaded to gross operating weight with cargo.

The passengers that morning presented a good cross section of America's army today: A colonel and a major enroute home, after three-year hitches, to a short furlough and re-assignment; a captain enroute to an assignment in Mexico—and a date with matrimony; a Yank magazine correspondent; and also 13 soldiers and sailors, finishing two and three year hitches and traveling under orders.

The north-bound route varied from the trip down, and nosing out over the Caribbean at the earliest possible moment brought forth the Short Snorter bills and an expensive morning for a gullible flight engineer. Some of the first leg of the north-bound trip gave jungle-bound Central American natives a good view of a formation of cargo planes, since the passenger-laden plane caught up with one of the cargo craft shortly before mid-morning.

Re-fueling took place at a West Coast Guatemalan outpost, but it took no longer than before. The new flight crew came aboard with three additional passengers—Guatemalan Air Force officers enroute to the United States to take fly-away delivery on training planes to add to the growing strength of Central America's aviation.

Arrangements had been made by radio to insure that the captain could keep his aforesaid date with matrimony in Mexico City via commercial airliner from Banana Run's stop at a sweltering east coast port. And before completion of re-fueling—both of plane and passengers—he and the cargo destined for that stop had long since been off-loaded.

There, too, was evidence of the training young Army pilots get. Young Lieut. B. was flying when the radio report came in, giving a 200-ft. ceiling. He "sweat it out" for quite a while, but on letting down found but a few wisps of cloud at 200 ft. The landing he made was one of those that even old pilots thrill to. Thinking it had been made by the contract pilot, congratulations were offered. But he, being a good instructor, promptly replied, "Thanks, but the Lieutenant did it. The guy's got me worried about my job." He had seen enough expansion to agree with the vast majority that the "old hands" don't have to fear for their jobs.

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HIGHLY STRESSED STEEL PARTS . . .

WELDED . . .
TUBULAR ASSEMBLIES . . .

. . . FOR AIRCRAFT NOW SUPPLIES THE NATION'S FIGHTING FORCES BY MORE THAN 50 AIRPLANE MANUFACTURERS.

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COLORADO SPRINGS COLORADO
Designers—Engineers—Manufacturers

Lieut. B. may have been an "eager beaver," but he's the kind who'll get the hot freight through to keep the pet fighter pilots in the air.

Unpadded wooden benches—the type which give added cargo space by folding against the wall when not in use—had become extremely hard near the end of the long day's flight. But none of the passengers appeared to mind. Most of them were getting back to the States, which seems to be the one ambition of every American soldier on foreign duty. They even sat patiently and without too much kidding as the radio operator, complete with "dead-eye" and a flit gun, filled the entire passenger cabin with spray. Department of Agriculture and U. S. Public Health Service rules were followed in war as well as in peace. They curbed their anxiety when their plane had to circle wide to follow one of the training planes which land and takeoff, many times every hour of the day to make more pilots for ATC runs. The first man out the door practically kissed the ground, patting it affectionately as he murmured "Good ol' U. S. A."

By the time the last passenger had been cleared through customs, immigration, and the censor, the ATC transportation officer on duty had completed arrangements to get them all on the way to their destinations. Long before that the operations officer had PX'd the schedules back to complete another day's flights. And just as long before, cargos had been off-loaded and the planes were in the nearby hangar being readied to start right back south again within ten hours.

Meanwhile, evidence of the swift expansion constantly going on was visible. The many new buildings, the added, strengthened, and lengthened runways, comprised progress toward the goal which will mean Banana Run's activities soon will be many times greater than they are today.

And still no one could say definitely how it came to be called Banana Run. All they can say for sure is that it's doing a job—a big job.

The Case for Integral Power Plant

(*Continued from page* 151)

to be gained if the airplane designer could be supplied with a proved integral power plant. This entailed the promoting of an additional establishment, with a group of power plant experts, complete power plant ground testing equipment, and numerous airplanes, to obtain full scale flight data.

"The results have been most beneficial in that the airplane designer is furnished with complete data on power plant and its installation, which will furnish maximum thrust for minimum drag and weight with the knowledge that the reliability of the combination has been proved. The benefit of the work is shown by the fact that three well-known multi-engine machines in Britain have similar integral power plants developed up to the bulkhead by the engine builder; this is, of course, in conjunction with the airplane constructor.

"Prior to the commencement of the present war, the Society of British Aircraft Constructors formed a committee from representatives of engine builders, aircraft constructors, and propeller and aero-dynamic experts to study the possibilities of the interchangeability of integral power plants with aircooled radial types and in-line liquid cooled types.

"The result of the studies made were really very encouraging and showed that by grouping the various engines into power classes, interchangeability was not only possible but practical, with surprisingly little concessions on cross-section of the bulkhead size.

"This study was made with particular reference to nacelles mounted on wings. It is, of course, conceded that improved airplane design may warrant rearrangement of power plant units, particularly of single-engine and twin-engine combat types. However, there will always be the heavier multi-engine type of craft in which integral power plants can be used to great advantage, and Dr. Moss' proposals are well worth careful consideration." This endorsement by Mr. Ellor is particularly pertinent.

Fig. 2 and 3 show two such English integral power plants made by the Bristol and Rolls-Royce companies, respectively and in present use. Illustrations also have been published showing similar plans with German planes.

The plan has been talked about in a vague way in America under the name "package power plant", "unit power plant", and "power plant ahead of the firewall", as well as "integral power plant". The new names, "power egg" and "ready-to-fly power unit" are shown herewith. Henry Ford's organization also has exhibited an ingenious plan of this general kind (Fig. 4).

It is understood that there are many plane designs in which it is not now feasible to execute the integral power plant plan. But if the plan is good, the time may come when this situation will change.

Lt. Comdr. Scrymgeour has very kindly written a discussion that he heads "Laying the Egg Plant". It reads:

"Let us assume, for the sake of argument, that the power plant egg is a good thing. Okay, who is going to design this egg, and for what plane?

"I see that we will have various

skill born of experience

Mercury craftsmanship was built up through more than a score of years devoted exclusively to the production of aircraft and aircraft parts; hence wartime demands found us with the equipment, experience and specially trained artisans to deliver vitally needed parts quickly . . . without the delay of plant conversion and the hazard of hastily trained workers.

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For instance, plant 2 is a completely equipped unit for fabricating and finishing of tanks of any type . . . forming, riveting, welding anodizing, testing and painting...progressing smoothly, steadily and swiftly from shining sheet to cartoned shipment.

Aircraft makers know they can depend on Mercury quality and deliveries alike, for tanks, surfaces, parts and accessories.

At the Cradle of Aviation

MERCURY AIRCRAFT INC.
HAMMONDSPORT · NEW YORK

The Mobile Machine Shop Prizes a Part from the Food Mixer

IT MIGHT SEEM strange that a truck equipped to make repairs in the field should find anything of value in a household kitchen mixer. The food mixer is a "lady's man" and so must be trim, light in weight, and stout-hearted. That's why food mixer manufacturers prefer Torrington Needle Bearings—their compact size and ease of lubrication give this modern kitchen equipment much of its "sex appeal."

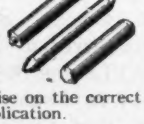
The mobile machine shop, on the other hand, is *designed* for repair work. Rugged, hard-driven, it is equipped with various kinds of machine tools to do just that. But it was the repair and servicing of planes, tanks and other mechanized equipment "knocked out" in battle that our Armed Forces had in mind when they designed the mobile machine shop. And the Needle Bearing's adaptability to machine tool design looked to Army engineers, as it did to the food mixer people, like just their dish. As it turned out, there were *other* features on the bill of fare of this unusual anti-friction bearing that any repair crew in the field would welcome—the ability to stand up in the severe service a mobile machine shop knows... effective lubrication, low coefficient of friction, increased efficiency of operation...and, of course, the fact that it needs so little attention.

NEEDLE BEARINGS— ALL TYPES—ALL SIZES

NEEDLE BEARINGS TYPE DC are complete, self-contained units consisting of a full complement of rollers and a drawn, hardened outer race. They offer the advantages of small size, low cost, high capacity—and easy installation.

NEEDLE BEARINGS TYPE NCS consist of a full complement of rollers and a relatively heavy hardened outer race. They are furnished with or without inner races. Needle Bearings Type NCS are adaptable to heavier loads than Needle Bearings Type DC.

NEEDLE ROLLERS TYPE LN are produced in a range of types and sizes for assembly on the job into low-cost, high-capacity, anti-friction bearing units. Our engineering department will be glad to advise on the correct size and type for any application.



THE POINT IS YOUR POSTWAR DESIGNS

In considering ways to improve your own product's design for postwar, there's more than one useful idea in the Needle Bearing. For war work has awakened many of *your customers* to the advantages, in performance and cost economy, of compact design, savings in weight, infrequent lubrication and long service life—features which identify the Torrington Needle Bearing. Torrington engineers will be glad to assist you in adapting this new-day bearing to your future designs. Catalog No. 114 listing sizes, ratings and typical applications will prove helpful, also, as preliminary information.

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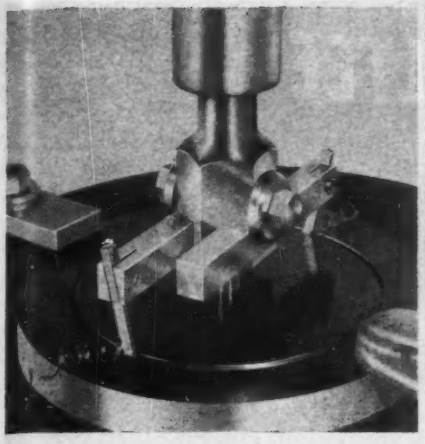
LET'S GO ALL OUT—KEEP 'EM FLYING

TORRINGTON NEEDLE BEARINGS



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Simplified, Long Life Design

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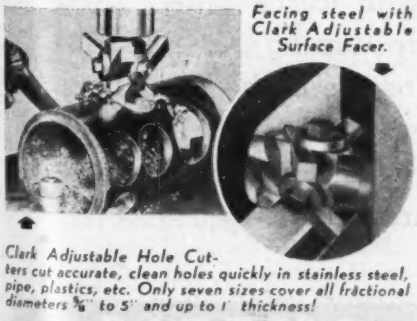
Write for Bulletin No. 000



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Clark Adjustable Hole Cutters cut accurate, clean holes quickly in stainless steel, pipe, plastics, etc. Only seven sizes cover all fractional diameters ⅝" to 5" and up to 1" thickness!

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Manufacturers: Precision Tools, Precision Parts

types of eggs because we have various types of planes, each having different requirements. Well, then, will some central agency say: 'This type egg will be installed in *all* dive bombers, this one . . ., etc.? Will this agency be a governmental function or detailed from and by the industry?

"And suppose there are six or seven manufacturers of horizontal land-plane bombers who not only feel they can improve on the egg sent them but can also prove it. Do they still have to use the egg laid before them and thus allow the enemy this unnecessary advantage?

"Or is this egg to be constructed to each manufacturer's specifications? If so, then the ideal visualized by Dr. Moss would be out of the picture. Dr. Moss is quite specific in expecting a standardized arrangement so that *any* plane of a given general type would take *any* integral power plant of the corresponding specification. But he didn't mean each manufacturer's specification.

"It seems to me that this standardization thing is being gone about backwards. It must be admitted that it would be very nice for every pilot to know he could in an emergency land at any field and find replacement parts for damaged material. But wouldn't this be more easily accomplished if the planes themselves were standardized? For example, when the Army put out bids for a certain type bomber, three manufacturers bid on it. One later withdrew, leaving the other two to design, build, and test their versions of the Army's general specifications. Having done so, one was probably better than the other and should have been concentrated on, even though one company would be building a plane designed by another.

"The point is that the Army would be getting the better plane and more of them, and they would be identical. Now they have to be careful to have spare parts available at each field whether or not that type is stationed there. And why? Just to satisfy the ego of the manufacturer who produced the poorer plane.

"Now for the replacement feature: Here again there are two angles to be considered—military and commercial.

"As for the military, whether in the field or aboard ship it will be much more convenient for the operating personnel to handle comparatively small, light objects. Handling the whole egg would be impracticable, if not impossible, without especially heavy gear, and while this is available in a carrier or at a home field, it's a pretty good bet it won't be at an advanced base—just where it would be most needed. The same argument holds for convenience and storage, especially aboard ship.

"Very few items in the egg will need replacement or repair sufficiently urgently to warrant replacing the whole

★ Another control problem—the kind Clarostat engineers like—came in recently. Specifically: a tandem assembly comprising dual 50-watt power rheostats and dual 3-watt wire-wound potentiometers; the latter insulated from shaft and ground for 2000-volt breakdown test; four units to have the same degree of rotation. In a hurry, of course; first a sample; then production running into large figures.

Clarostat engineers worked out the assembly here shown from standard units and parts, again demonstrating how time, money and effort are saved by the ingenious adaptation of the Clarostat wide choice of standard units and parts.

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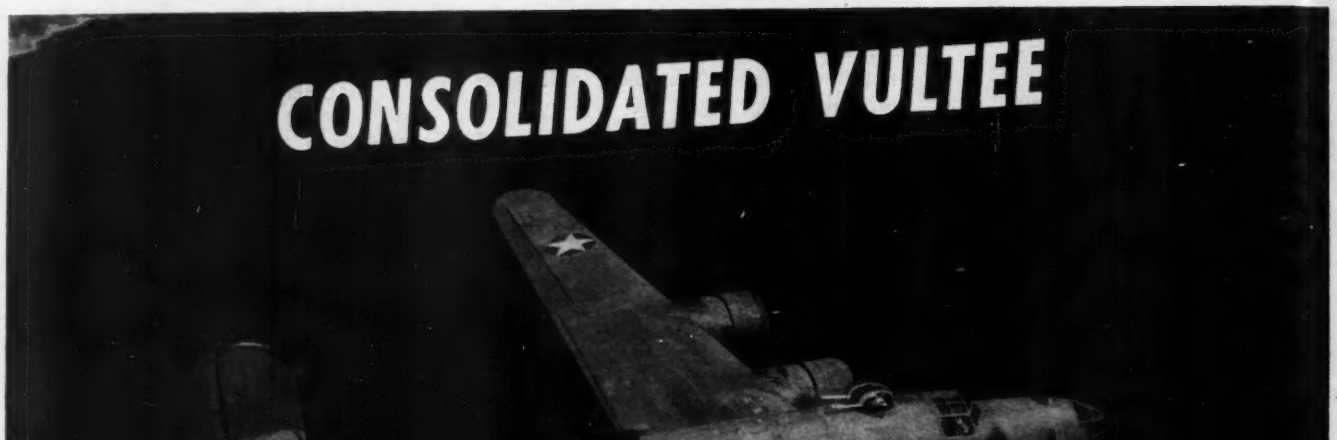
CONSOLIDATED VULTEE



RBC AIRCRAFT SERIES—#11
CONSOLIDATED B-24
LIBERATOR BOMBER

CAIRO, June 28 (AP).—U. S. Ninth Air Force Liberators shattered Axis hangars, pitted runways and started fires at two airdromes near Athens yesterday in a powerful followup to the Thursday raid at Salonika which opened the trans-Mediterranean aerial offensive against German and Italian holdings in the Balkans, it was announced today.

High explosives were loosed ef-

"South Pacific: (All dates are east longitude)

"1. On the evening of July 5, army Liberator (Consolidated B-24) heavy bombers attacked Japanese installations on Ballale Island, Shortland Island area. Five fires were started. About 12 Zero fighters attempted to intercept but were driven off. No U. S. losses were sustained.

"2. On July 6, in the early

uses

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NEEDLE BEARINGS

'Round the clock these heavy 4 motored Liberators are "block-busting" enemy installations from one end of the earth to the other. And 'round the clock we are turning out RBC Aircraft Needle Bearings for use in the wing flaps and landing gear of these B-24's—and for many other types of military and naval planes—bombers, fighters and transports.

ROLLER BEARING CO. of AMERICA

TRENTON . . . . NEW JERSEY

egg. If the trouble is due to hits from gunfire, either of large or small calibre, it is probable that more than the egg will need replacement. If any accessory needs replacement due to malfunctioning from other causes, it will probably be about as easy for the ground crew to replace the known miscreant as to change the whole set-up, including all lines and wires.

"In the commercial field, the aviation world might offer a better nest for the power plant egg. I say 'might' advisedly, for the same arguments re repair or replacement of *parts* when possible, rather than the whole egg, will hold even more tenaciously here because of one little item often forgotten when comparing military with commercial aviation—that is, manpower and the cost of maintaining same. In peacetime the armed forces not only can change at will the number of planes they operate, but they don't have to meet competitive schedules and they don't pay their men by the hour or have to show their shareholders a profit. Men work until their tasks are completed and they don't get *anything* extra in peace or war, much less time-and-a-half.

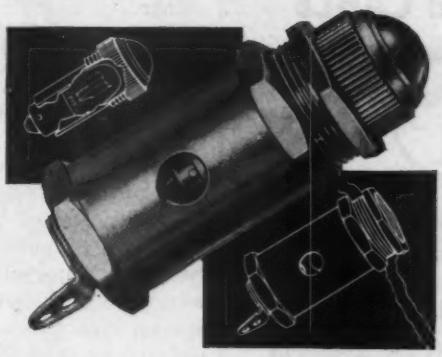
"All in all, then, many cases can be pictured where the power plant egg not only would be welcome but helpful. But in any case it would apply only to that model plane for which it was designed. The simplest answer to that is that no airplane manufacturer in the United States employs exactly the same power plant installation in any two of his own models, much less the same as that in the product of any competitor. In fact, many use different installations in the same model.

"In spite of the opinions of various fireside experts (Dr. Moss obviously fails to fall in this category) this is not bullheadedness on the part of the manufacturers. They make what their customers want. If they don't, they go out of business. It is this very variety and competition between designers which is responsible for the extremely rapid advance in aircraft power plant installation design in the last few years. Competition is not only the life of trade—it is also the very essence of progress and improvement.

"In any case, my personal opinion is that Dr. Moss' picture of interchangeability between plane models not only is not attainable but it is also undesirable if we expect or want improvements and progress, which we all most certainly do both in wartime and peace."

Thus, Comdr. Schrymgeour concludes his side of the discussion, but it by no means eliminates an opposite point of view. Rather, it is to be borne in mind that the plan we are presenting in this two-part series (and as illustrated in Fig. 1) will destroy no initiative but instead will lead to aviation power plants

Another NEW Gothard



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- Bulbs change from the front without disturbing wiring.
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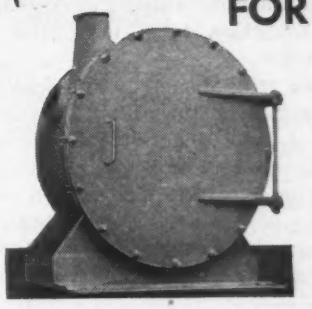

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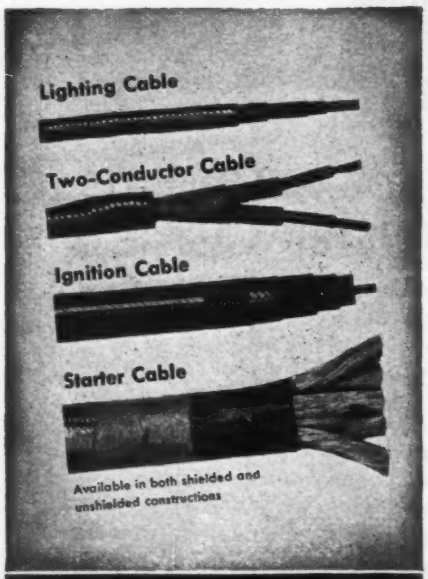
There *was* a time that Wiry Joe was merely the largest independent manufacturer of replacement wiring for the automotive industry.

Now, Wiry Joe is also known as an important source of supply for every type of electrical wire and cable for aircraft. The complete line includes starter cable, high-tension cable, primary cable, both original and replacement. Wiry Joe also makes power and welding cable.

And just as Wiry Joe automotive cable won a name for quality, so, too, has Wiry Joe aviation cable. Every item in the line is built to meet rigid Army and Navy specifications, and is produced under the Dostam method of manufacture for uniformity, dependability, high efficiency and long life.

Inquiries regarding wire and cable for any type of service will be answered promptly.



Wiry Joe
AVIATION CABLE
manufactured by
THE CRESCENT COMPANY
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so specialized as to represent an unified art. In this way, there will be accomplishment of all the progress hoped for both by Comdr. Serymgeour and by the author.

Advantages of Integral Power Plants

To American engineers and manufacturers, who have brought standardization to such a high pitch, the advantages of this integral power plant plan should seem obvious. No doubt the plan was originally started to permit rapid replacement of power plants or airplane structures damaged in the field during war. We in America have not been up against such problems very long, and so perhaps we have not caught up with the integral power plant scheme in spite of our boasted skill at mass production.

But ease of replacement is a major advantage *both* in war and peace. Rapidity of production so much needed in wartime now is being furthered by the manufacture of various components in parallel as independent groups which are later assembled to give a complete apparatus. The integral power plant helps this nicely.

The integral plan will enable improvements to be made with greater ease. A redesigned power plant section can be used with an existing plane design, or a redesigned plane with an existing power plant. And there surely will be redesigns.

Discussions of the Plans

After the brief presentation of these plans at the aforementioned SAE meeting, a little discussion was published. Since then a number of engineers have been kind enough to send the writer additional discussions. Here in Part I, four men have been quoted, and in our concluding Part II (to appear in Oct. AVIATION) the views of various other men will be offered. Particularly it will be seen that these engineers have quite different ideas, both pro and con, all of which bear pertinently in our analysis.

We will open Part II with a consideration of turbosuperchargers in integral power plants. Then we will present our proposals of a definite plan for the integral plant system which it is hoped takes into account all of the pros and cons expressed by the industry and service men in our symposium.

[1] *SAE Journal*, Feb. 1943.
[2] *Aero Digest*, Mar. 1943.

America At War

(*Continued from page* 113)

tirety was a military installation. Even the man in the corner grocery (if such there be left in Nazidom) was a small part of the great organization engaged principally in producing submarines to attack our shipping. In Hamburg—as

designed for time saving

Quick-precision shimming with Laminum often cuts assembly time 20 to 30%. Is introduced without fuss ... also eases shop, maintenance and service routine.

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every where else in enemy territory—worker displacement is definitely a part of Allied war on the Axis.

But precision bombing had its innings during the month. Outstanding was the raid on the Ploesti refineries, when Consolidated B-24 *Liberators* made a 2,400-mi. round-trip—fought their way into one of the world's most heavily defended areas to dump 300 tons of bombs on the greatest single source of Luftwaffe gasoline. The *Liberators* went in at roof-top levels in the "greatest low level mass raid in history" with 175 planes participating. Our casualties were 31 planes, but the enemy lost 51 defending fighters plus a vital material installation.

Fluidity of war being what it is, you can be reasonably certain that the Allied command has not, as of any given time, decided whether to expect a German collapse as a result of air attack. There is always the tempting theory that Germany's estimated 1,000 sq. mi. of production plant, scattered in many places, can be knocked out with 600 tons of bombs to the square mile. It sounds attractive. But when you figure it out, at the rate of 2,000 tons a day (which is fast work), that kind of program would still take a long time and it would cost a lot in terms of money.

But it would cost less in terms of men, which is more important. The Allied peoples who are supporting the war would rather give time and money than give their men. On the other hand, time is what the Axis wants. It knows time will beat it by attrition at the present rate. But Axis leaders hope that we and our Allies will get tired of fighting and quit in two or three years. They may have something there, at that, judging by recent moves of production chiefs. We have to keep hitting the ball.

And there are the Russians. Our land war is still small time stuff compared to theirs. We have hundreds of thousands actually in combat, to their millions. Their losses are proportional. They are not sure what results our bombing will bring, and they still want us to wade in and fight on the ground. There have been signs lately that the Russians might bank their fire, hold the line, and free the Germans in millions to fight in the West. If they did that, we would be up against pitching in with bayonets and machine guns and huge losses, or letting the war drag on. Strategic air power advocates say that we should have prepared an air force, from the beginning of the war, that could put down five or ten thousand tons of bombs a day, which could beyond doubt plow up those thousand square miles of German plant.

They say—perhaps glibly—that it could have been done with relative ease if we had put our major energy on it

instead of on now-obsolete tanks and other equipment for a walking army. But no man can yet say who is right about that. And besides, it is a by-gone hardly worth spending words on.

Regardless of pros and cons on air power, Allied strategic aviation has done a swell job as it stands, and everybody admits it. In Tunisia and Sicily, air attack blistered enemy ground in preparation for our advancing troops, almost beyond belief. Officers who were on the spot tell these writers that the Germans were dismayed. They expected at least to fight a hard delaying action that would be a credit to their reputations. Instead, they found their supply routes torn up, their air fields unusable, their air transport shot down, their ships sunk, and their troop concentrations riddled. Wherever they turned they were frustrated. They had to surrender, and sadistic Nazis wept.

The Allies have a big advantage in freedom from attack on their air industries, as noted earlier. Their next biggest advantage is simply in their alliance. Britain and the United States have achieved a degree of cooperation for which their statesmen deserve fully as much credit as do the smartest generals in the field. Between the two, they have developed a complete "line" of airplanes for all purposes. These designs sprang partly from fundamental differences in basic philosophy and partly from intelligent analysis of war experience and production of types to do the job.

For the Axis this formula carries the minus sign, for in fact there is no Axis. Italy was always a liability, and Japan serves only as a diversion, although a nasty one. The Japs and the Germans have no common interest except aggression on other peoples' property. They have no aviation production teamwork to speak of, and if they did have they couldn't bring it to bear in action on their separate fronts.

Germany's air blitz taught the world a lesson in air war which will not soon be forgotten—or will it? The side that develops its air force last has a distinct advantage. A big program of frozen designs is a good thing if it wins in a blitz. But if the victim recovers enough to build air power, as the Allies did, he has seen all the tricks and can design to beat them. Of course there is no substitute for industrial power, which the Axis forces never had in sufficient measure. Their great power was in a spring which they had been winding up for seven years. It is running down. Our power is an engine with plenty of fuel for constant operation.

A strategy as old as the hills has been put to use by the Allies in the air attack on Europe. If a bomb hits a target and puts it clean out of busi-

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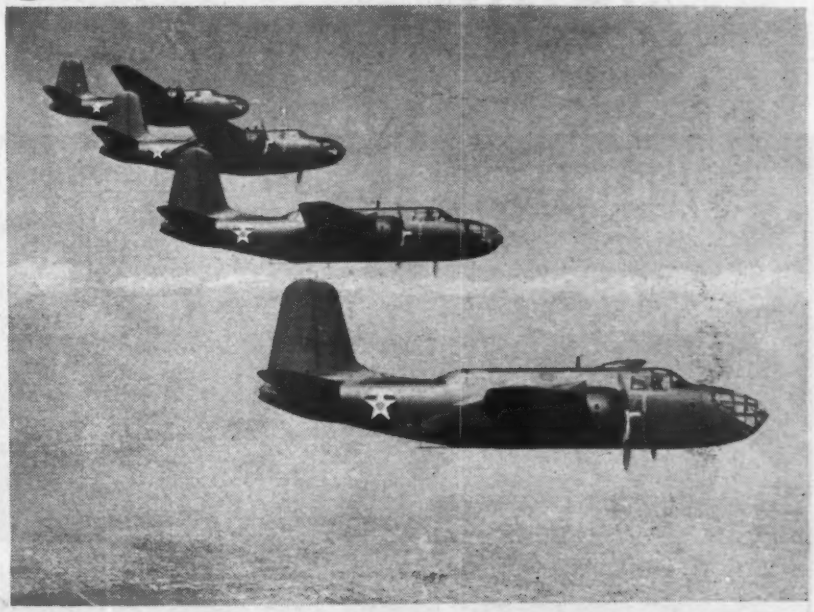

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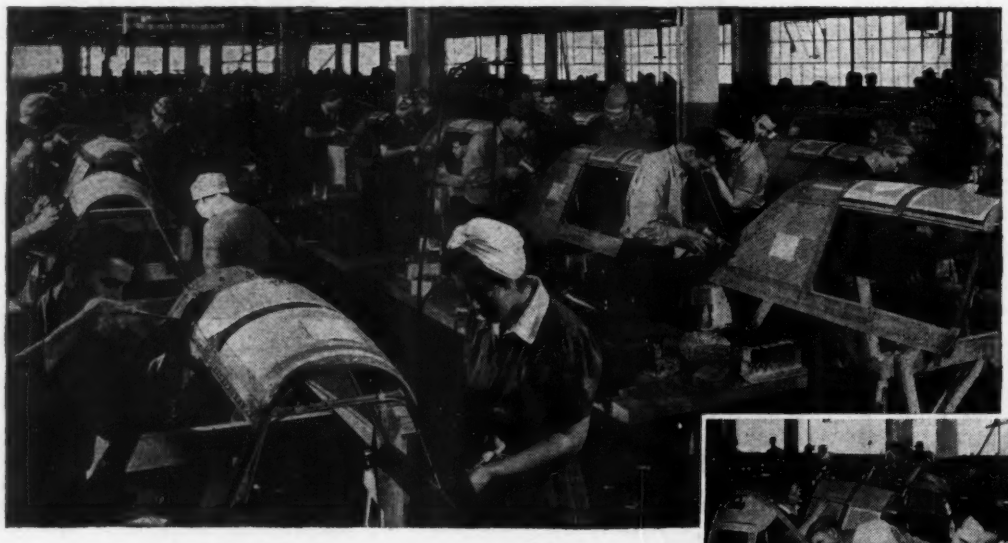

In two of Libbey·Owens·Ford's plants, large-scale production is concentrated on assembly of canopies for fighting craft. At the right, installing Bullet-Resisting Glass windshield.

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★ Libbey·Owens·Ford's production of wartime materials is illustrated by the above scenes showing assembly of aircraft enclosures. In the larger, the assembly of a canopy, or "greenhouse", for a well-known fighting plane is nearing completion. The windshield shown in the smaller photograph contains Bullet-Resisting Glass, a product of L·O·F Research for better vision and greater protection.

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ness, that is fine. But if the target is only crippled and is subject to repair, it is then left alone—until a lot of time and material has been put into rehabilitation. Then it is hit again. It's the same as the old saw that a wounded man is worse for the enemy than a dead one; he requires attention whereas the dead man doesn't.

In the Pacific progress is slow, but more and more American planes are getting into the fight. Formations of 150 and 200 heavy bombers are now frequently reported attacking Jap positions. Up to 150 tons or more of bombs have been laid on a target in one day. This sounds small in comparison with operations in Europe, but it is nearly as big as some of the Nazis' heavy attacks on England. It's heavy stuff in the Jap league, and their news commentators have already been telling the people of sorrowful air defeats.

London says that a fleet of *Liberators* is being built up in China at points from which we could hit Japan. This could be so, but the highest American air officials have said that there is no gasoline in China. They indicated we would have to wait till we can assemble enough air and sea power on that side of the world to take bases which can be supplied. It may seen strange that the United States Navy, which is bigger than Japan's, cannot do the trick. The reason is, as high commanders have explained, that it takes many times the strength of the enemy to hit him when he is thousands of miles away.

The Japs may not have to wait till Germany folds to get theirs. Germany's submarine fleet and the evasive Italian fleet are both being liquidated, with the result that British sea power will be increasingly free to join American forces in their task of taking bases north and south of Japan.

Here at home, production has nearly levelled off just above the 7,000-plane-per-month mark, as this is written, but Donald Nelson is saying we must achieve the 10,000 rate by the end of the year. In general—there are exceptions—the flow of materials and components to airplane producers is satisfactory. Manpower is all right in some parts of the country, but in others it is terrible. The industry's only chance of getting any number of good workers is from plants cut back in other lines.

The two worst impediments of airplane production are design changes and the let-down attitude that is resulting from victories. Nelson and all his people are trying their best to find answers to these problems. They want to make the goal, but privately they are well pleased with what has been done. The enemy can be taken with the present rate of output, but most everybody wants more planes to do it quicker.

We can do the job with current types,

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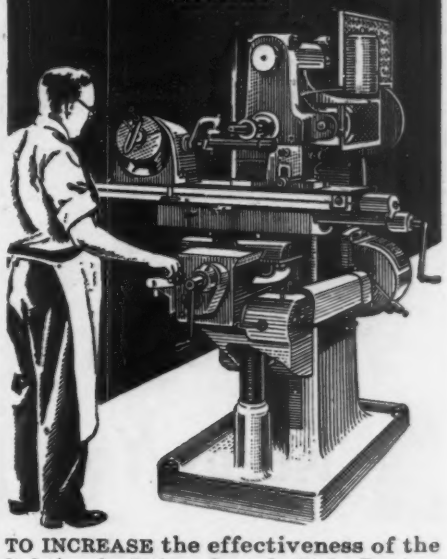

TO INCREASE the effectiveness of the lighting facilities, plants built for Boeing, Consolidated, Douglas and North American have light-colored concrete floors made with *white* portland cement instead of with *gray* portland cement or other darker materials.

Tests in Consolidated's plant at Fort Worth show that the white-cement floor compared with a gray-cement floor in the same plant reflects 61% more light to underside of wings and provides 20% more light on vertical faces of work.

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go, but in case it takes some time yet we would want a number of new fighters that are in the works, two or three bombers, and other combat planes. To that end Dr. George Lewis, research director of the National Advisory Committee for Aeronautics, is doing some special work with manufacturers, hurrying their development programs. What we want now, as always, is more speed and more range.

Some weeks ago the Aircraft War Production Councils came up against a problem for which no provision had been made. In fact, provision had been made *against* it. The Council had agreed when it was organized not to participate in politics, often called lobbying. But important legislation recently came up, dealing with the disposition of surplus airplanes after the war, disposition of plants, and other matters. The Council was powerless to get in and bat for itself. That is what inspired the industry to get busy and reconsider the reconstitution of the Aeronautical Chamber of Commerce which, as a result of internal quarrels, had been laid on the shelf for the duration. Quite likely the Aero Chamber will be better than ever. A hunt is on for two high octane executives to run it.

And to complete this 21st review of American aviation at war, let us glance at the airmail situation. Though half of the airlines' planes were taken long ago, and the government has since loaded up the other half with priority cargo, inert and on the hoof, the Post Office still likes the people to believe that the airmail is being flown. So it doesn't tell them any different. You can't blame the P.O.; it never wants to see that airmail deficit again, and it doesn't want trouble with airmail ratings. The airlines didn't want to announce their troubles and lose their best customers, either. But they don't mind if the press makes a squawk.

Airline operators know that the Army is fooling around with cargo planes on the ground that ought to be in the air. And if Army can do that, it can dish up some planes to expedite war business. About 20 four-engine planes would do the job, they say.

Bombing the American Way

(*Continued from page* 119)

enemy's power to fight back and will, in most instances, determine the scope and intensity of future tactical situations. This is the fundamental task, and use for any other purposes is generally considered carefully.

If an enemy airfield is close enough to be dangerous to our own positions it generally lies within the immediate tac-

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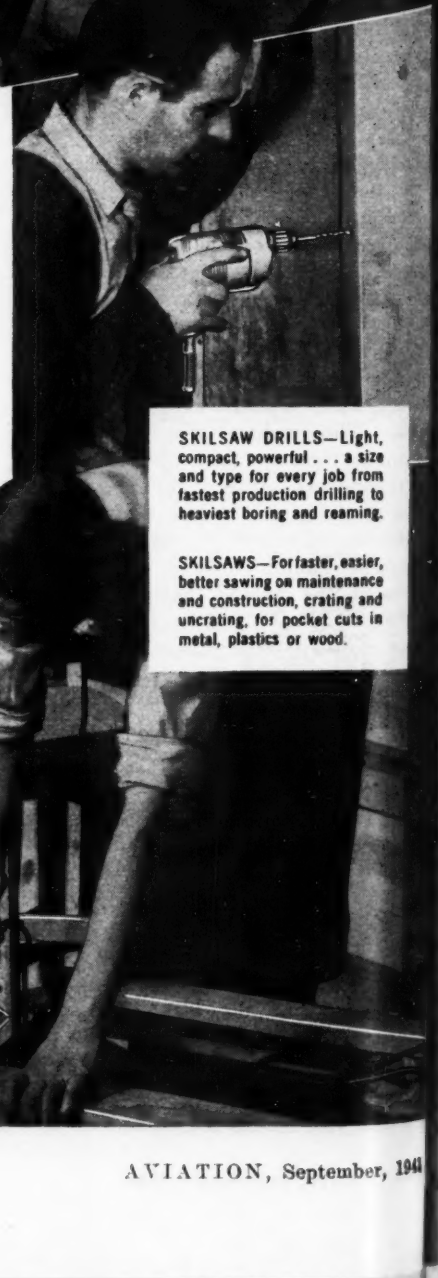

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eal theater. Therefore, weapons designed for strategic purposes, such as heavy bombers, should not as a general rule, be risked to make continuous raids against such airfields. Tactical weapons are called for, and medium or light bombers are to be used.

About the only time use of heavy bombers against airfields is justifiable is when a tactical situation calls for employment of all available power. For example, if nearby enemy territory is to be occupied, or if for any other reason enemy air effectiveness is to be nullified for immediate operations, it is proper to employ heavy bombers against these installations. This does not hold true if the enemy is to be permitted to recover use of the field. A possible exception to this is in instances such as the battle of the Bismarck Sea, where enemy air power was pinned down to permit operations against a convoy. But this was a definite tactical situation where it was legitimate to use any weapon available to accomplish a vitally important mission.

The error of using heavy bombers for routine bombing of airfields may be compounded by wasteful employment of heavy bombs. Fragmentation bombs are most effective against grounded aircraft—which are generally the principal targets unless service installations are extensive.

Operating Technique

Assuming that a correct bombardment philosophy has been established, that the most effective tools have been developed, and that proper selection of these tools with respect to targets has been made, the next consideration is the actual technique of employment.

The mission of bombardment is to destroy the enemy, and techniques are developed with full consideration of all factors involved. Because bombardment is essentially an offensive mission and involves penetration into enemy territory, resistance must be expected and techniques must be developed to deal with that force so that the mission may be accomplished. Protection of the bombers force is, therefore, a vital factor. An error in concept here may well prove fatal.

Using the terms "defense" to mean bomber force protection, and "offense" to mean bombing the enemy, it is generally true that defensive techniques detract from the offensive effectiveness of a bomber force, and vice versa. For example night bombing, which is reported to principally for defensive reasons, is considerably less effective than day bombing. On the other hand, loss risk may be higher in daylight than at night if sufficient defensive firepower is not available.

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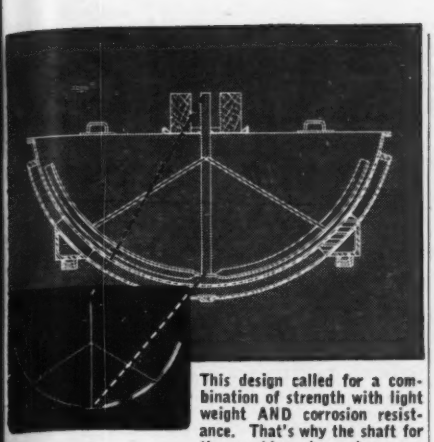

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However, there is another factor which has a profound influence on operations; this we must categorically label "altitude." For consideration of this factor, level bombing is subdefined as "high level" bombing and "minimum altitude" bombing. Each is a distinct and basic technique offering possibilities of a tremendous variety of tactics to accomplish a mission or meet a situation.

Altitude Considerations

The term "high level" must be interpreted with caution because minimum bombing is employed at levels up to, roughly, 300 ft., and any level bombing operation above that altitude is high level. There is a definite physical reason for this definition. In minimum altitude bombing, the airplane is flown *at* the target and the principal component of a trajectory is horizontal. In high level bombing the trajectory is more or less vertical.

A direct hit against a target in minimum altitude bombing can be made only if the airplane speed in mph. is something in excess of its altitude expressed in feet. This is illustrated on page 118, which shows a minimum altitude attack against a heavily armored ship where, with units of mph. and feet of altitude equal, the bomb strikes the surface and does not reach the target directly. Inasmuch as the height at which minimum altitude attack may be executed is dependent on the airplane speed, it is obvious that this limit can be readily established and that it would rarely exceed 300 ft. with airplanes of present day performance.

With respect to employment of bombing aircraft at altitude, the general rule is to *operate at the lowest possible altitude consistent with bombing effectiveness and losses that can be afforded.* This may range from ground clearance altitude on up to 35,000 ft. and it is well to have equipment available to conduct operations throughout this range.

Loss Factors

Minimum losses should always be an objective, but the term is relative and should be determined in the light of results achieved. For example, the loss of one heavy bomber on a mission against a lone enemy destroyer is far less tolerable than the loss of 30 bombers out of a force operating against the Ploesti oil fields.

Assuming that the enemy has "adequate" defenses, the greatest margin of safety for bombers lies at either extreme minimum altitude or extreme high altitudes. At minimum altitude it is difficult for ground elements to track a speeding low-flying airplane and to bring their guns to bear, except where gun emplacements are extensive enough to set up a barrage. At the same time,

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fighter aircraft are at a disadvantage because of limited diving ability. Medium and light bombers are most suitable for minimum altitude work because their relative maneuverability and high speed enable them to dodge defense barrage patterns more effectively and to elude fighter opposition. The heavy bomber is not sufficiently agile against determined opposition at low levels.

As the pattern of employment of aircraft types takes more definite shape with experience we see the medium bomber gradually taking over exclusive assignment to the minimum altitude technique while the heavy bomber specializes in the upstairs department. With simple fixed-angle sights, minimum altitude bombing is highly accurate—a highly thought-of technique where conditions permit.

Medium bombers are used for high level bombing, too, just as heavies have been employed in minimum altitude operations.

Generally, however, the heavy bomber is equipped with a synchronous precision bombsight which requires tracking the target by the bombadier. Just as it is difficult for ground gunners to track a speeding low-flying airplane, a bombardier has considerable difficulty in tracking a target on the ground.

Tracking error is a human error which diminishes markedly with altitude above 3,000 ft. However, the mechanical error of a bombsight and other instruments increases with altitude. With an average total error of 4 mi. per 1,000 ft., this does not become too serious unless the operation is from extreme altitudes. However, it is a good reason for operating at lowest altitude consistent with average human error and adequate defense considerations.

Adequate ground defenses are most effective within the ranges of 300 ft. (automatic weapons) to 12,000 or 15,000 ft. (heavy anti-aircraft weapons). However, there are many instances where ground defenses are not adequate or where the target justifies losses—in which case operations may proceed at most favorable altitudes.

Formation

As stated before, factors which tend to enhance bombardment effectiveness also tend to decrease a bombardment force's defensive ability. As a matter of perfection, if a single bomb is aimed anywhere but directly at a target, it implies area bombing technique and involves a waste of bombs. By far, the most efficient employment of bomber aircraft is for each machine in the raiding force to make an attempt at the target with all possible precision. The hit probability *per raid* rises enormously under such employment conditions.

If a single plane attacked in such a manner, however, it would be seriously exposed to the combined effort of anti-aircraft installations as well as enemy fighter opposition. A considerable number of individual bombers attacking a target simultaneously from a variety of directions and at varying altitudes will offer considerably less opportunity for accurate anti-aircraft tracking, but exposure of individual bombers to fighter opposition remains a problem. This is best solved by tight formation flying where a concentration of fire power can be mustered in any direction against fighter opposition and all bombers in the formation can act for mutual protection. Such formations, however, reduce the offensive efficiency of the bomber force.

Efficiency Growing Apace

The question of formation flying is very much open to development and perfection. Agreement on precise tactics is difficult to find among a group of tacticians. Some hold that the answer to both successful attack and defense is larger formations. Others hold that formations should include a minimum number of aircraft which can provide adequate mutual protection against attack from any direction. This number has not been determined and the answer is, so far, elusive. "Minimum number"

(*Turn to page* 341)

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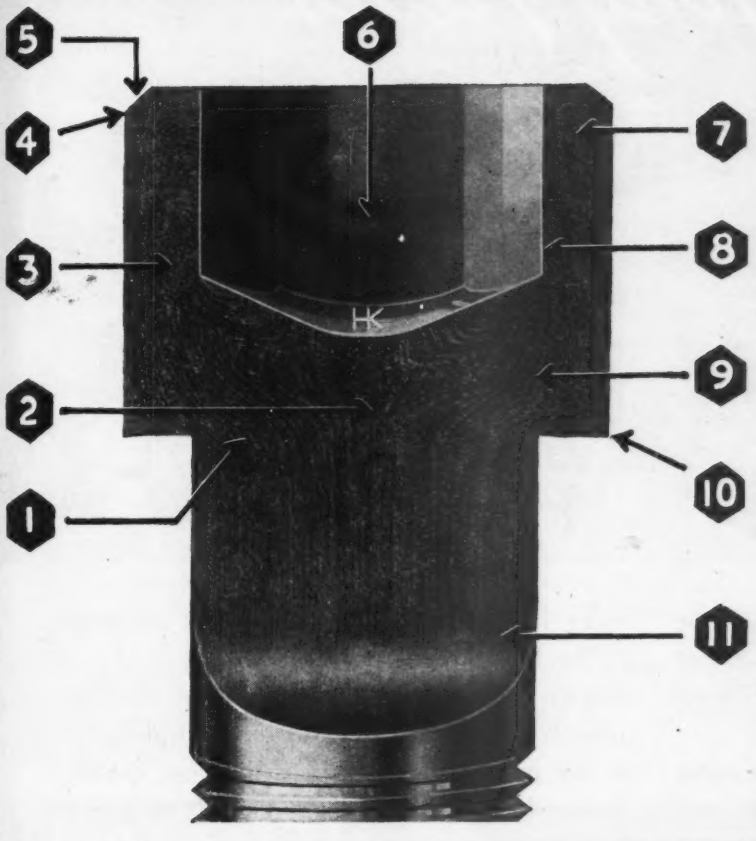

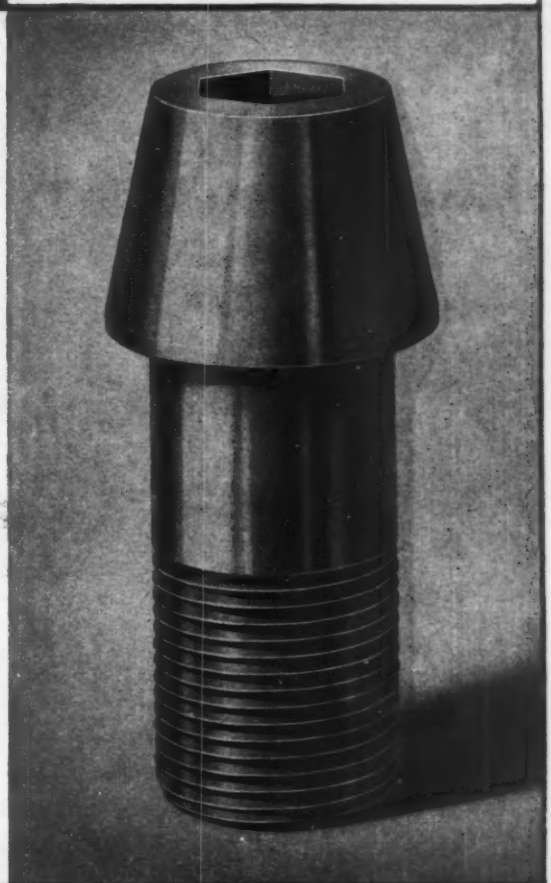

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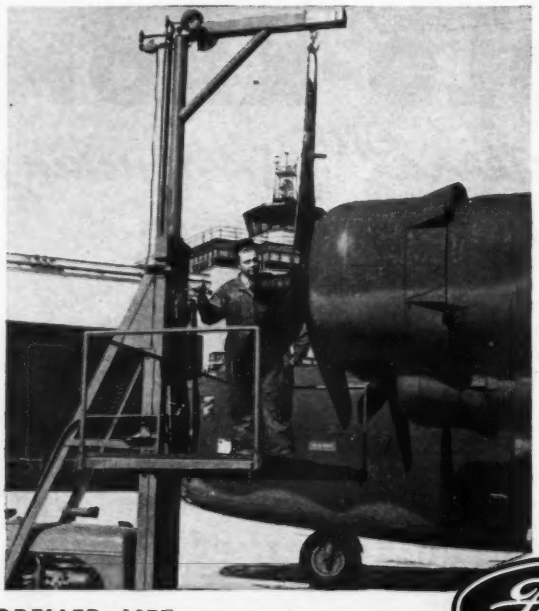

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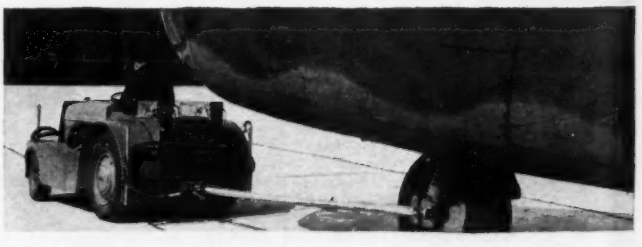

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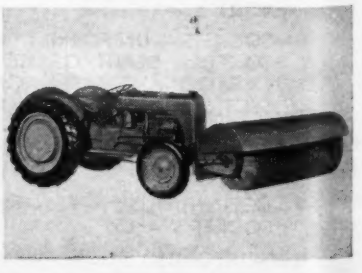

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(*Continued from page* 338)

is in line with the efficiency theory, just as minimum bomb load to accomplish a mission is predicated on the striving for efficiency.

However, the AAF is operating substantial forces in a great variety of theaters and it seems certain that if there is an answer to this problem of correct formations, where a number of answers appear to be probable, the AAF will develop it along the lines of accomplishing its mission with the greatest possible efficiency. From this, the incorrect impression may be gained that our bomber forces are now flying in hit or miss fashion. On the contrary, the extreme flexibility of organization stressed in the preceding article (Aug. AVIATION) has provided for maximum adaptability to mission requirements. Much of this detail cannot be revealed for security reasons, but the determining factors are outlined in essence above.

In summary, the AAF bomber commands have developed a positive approach to their mission of destroying the enemy. They have developed a workable philosophy, highly effective tools, and a forceful organization. They have shown a high degree of ingenuity in employment. The entire structure has been built on the solid rock of efficiency.

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